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A TECHNOLOGY FOR BETTER FOOD PRESERVATION

GIVING FOOD A BETTER START

SUSTAINABLE DEVELOPMENT GOALS

PureFize® broadband UV technology for improving food

PureFize® killing virus, bacteria, spoors, molds & other germs

PureFize inactivates cells by disrupting their cellular membranes and damaging their DNA or RNA.

If cellular processes are disrupted because of DNA damage, the cell cannot carry out its normal functions and reproduce.

The unique PureFize® Broadband spectrum

Normal UV-light sources either produce UV-C, UV-B or UV-A.

PureFize uniquely produces all three intervals, giving it unique properties and advantages.

PureFize® functionality for food preservation

PureFize has been proven highly germicidal.

By harnessing the power of PureFize broadband UV spectrum, we can eliminate the microorganisms that break down food and extend the shelf life of foods.

Giving food a better start

More than 50 percent of all European food waste takes place in our homes. At the same time, there are extensive data proving UV to enhance food quality and extend shelf life of food. Our objective is to improve food quality and by doing so reduce food waste at home.
We have based our initial knowhow on several sources such as external studies, our own internal pilot studies as well as data from ongoing partners collaborations, of which some cannot be disclosed at this point.

Food deterioration happens for two main reasons:

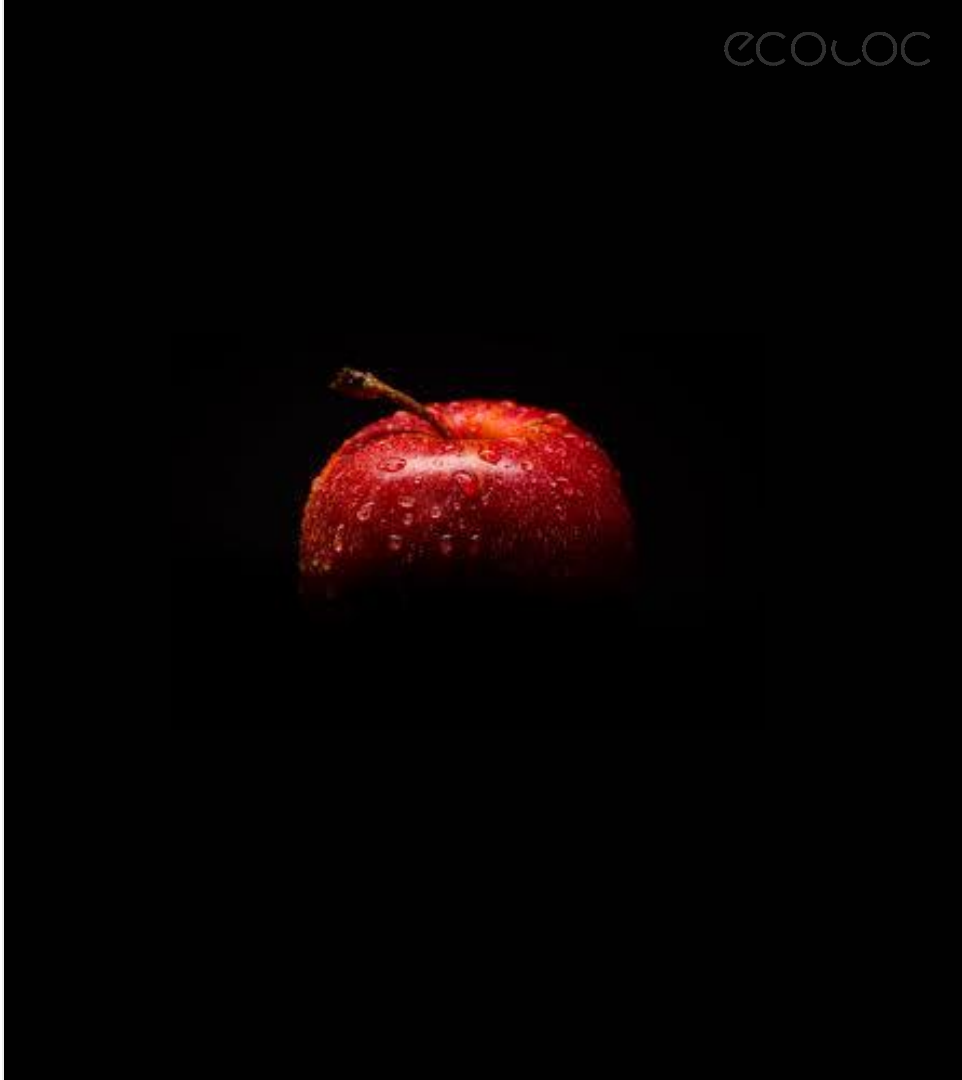
1. Autolysis or self-destruction of the tissue caused by enzymes present in the food matrix.

2. Microbial spoilage caused by the growth and activity of bacteria, yeast and molds which frequently come from the air, water and land, people and/or animals and due to cross-contamination with contaminated surfaces or utensils.

   The microbial activity mainly initiates on the surface of the fresh produce or cooked food.

PureFize®, is a new Swedish UV light technology, with a broadband spectrum (UV-A, UV-B & UV-C) that is effective to significantly reduce or eliminate both spoilage and pathogenic microorganisms on food surfaces, where the highest levels of germs are expected to be naturally present.

The EcoLoc™ product, with built in PureFize functionality, can improve food quality such as appearance, aroma, texture and taste. In doing so EcoLoc can extend shelf-life of foods, ensure safety and reduce food waste.



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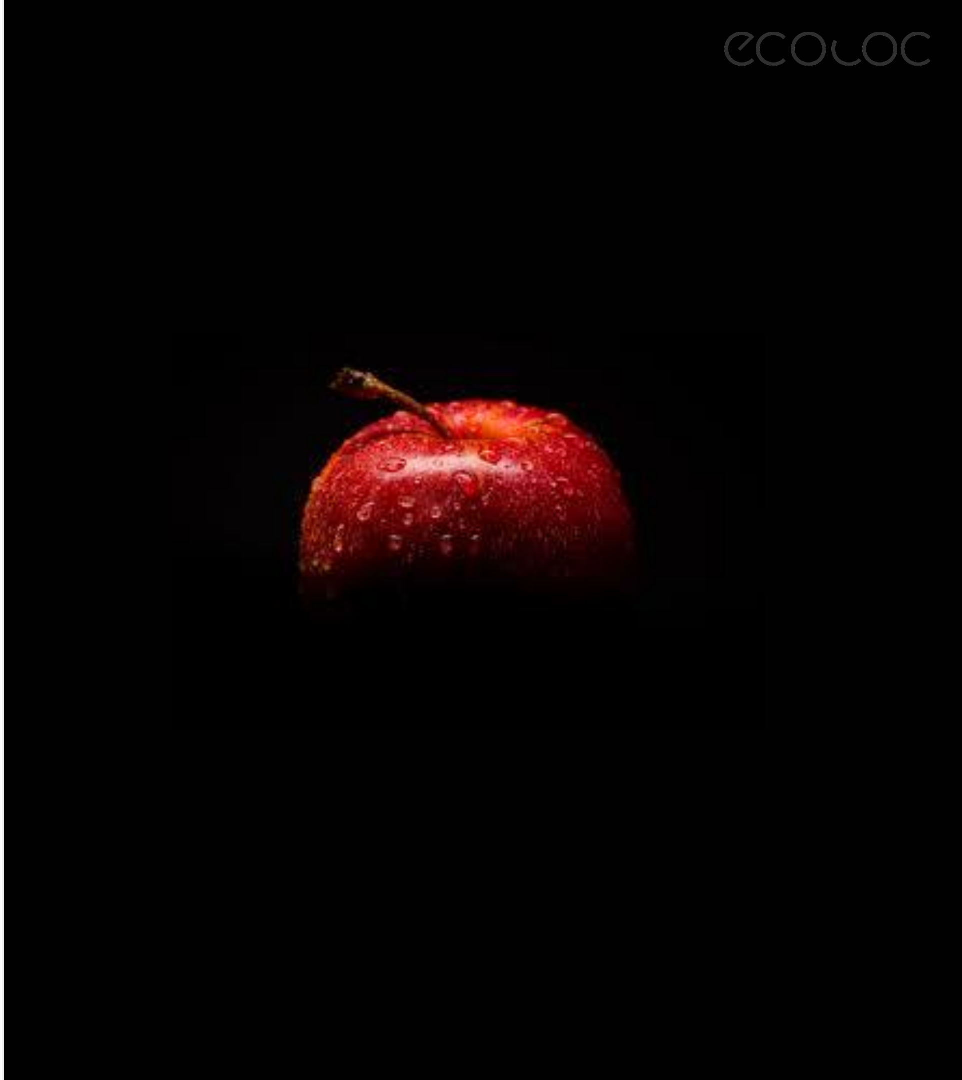
The role of EcoLoc is much more than avoiding mold

Regardless of whether food is still edible or not, beyond a certain point in time, we hesitate to eat it out of fear of getting sick. However, when we store food in the freezer, we know that it will last longer, and consequently, we feel safer eating it even after extended storage periods.

There's a limit to how long we're willing to keep food stored in the refrigerator. Sensory assessment, including how it looks, feels, smells, and tastes, plays a central role in our decision-making process regarding whether to eat something or not.

The role of EcoLoc is to give any food stored in the refrigerator a head start. By removing and/or reducing microorganisms, which are the main factors in food decay, EcoLoc helps to keep food fresh for longer. This doesn't just entail postponing visible mold; in fact, once the food has started to mold, it has likely already turned bad long before that.

EcoLoc maintains the overall freshness and nutritional value of vegetables, fruits, and leftovers. As a result, EcoLoc improves the sensory appeal of these foods, making them more enticing and enjoyable to consume.



Food deterioration is a complex process influenced by various factors

- Inhibited by EcoLoc
- Inhibited by cooling
- Inhibited by cooking
- Promotes bacterial growth

1. Microorganisms:
- Bacteria, Mold, and Yeast: Microorganisms can spoil food by causing decomposition, off-flavors, and the production of toxins. Refrigeration and proper storage conditions can slow their growth.

2. Enzymes:
- Enzymes naturally present in food can lead to color changes, flavor deterioration, and texture changes. Heat treatment (cooking or blanching) and freezing can help inhibit enzyme activity.

3. Oxidation:
- Exposure to air can lead to oxidative reactions, causing the deterioration of fats, leading to rancidity, and the breakdown of vitamins. Packaging, antioxidants, and proper storage can minimize oxidation.

4. Moisture:
- Excess moisture can contribute to the growth of microorganisms, spoilage, and the development of mold. Proper drying and packaging help control moisture content.

5. Temperature:
- Inadequate temperature control can lead to the growth of spoilage microorganisms and accelerate enzymatic reactions. Refrigeration or freezing slows down these processes.

7. Physical Damage:
- Bruising, crushing, or physical damage to fruits, vegetables, and other perishables can accelerate deterioration. Proper handling and packaging help minimize physical damage.

8. Chemical Reactions:
- Chemical reactions, such as Maillard browning, can affect the color and flavor of food. Proper cooking methods and storage conditions can control chemical reactions.

9. Packaging:
- Inappropriate packaging materials or methods can allow the entry of air, moisture, or contaminants, leading to deterioration. Proper packaging, including vacuum sealing and gas flushing, helps preserve food quality.

10. Time:
- The duration between harvesting, processing, and consumption can impact food quality. Freshness and nutritional value decrease over time.

11. Contaminants:
- Contaminants, such as pesticides, heavy metals, or chemicals, can contribute to food deterioration and pose health risks. Adhering to food safety regulations helps minimize contamination.

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EcoLoc effect on mold and other microbes

a) Rise
b) PureFize Food Lab
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RISE study affirms the effectiveness of EcoLoc™ and PureFize® in food preservation technology

In an era where food preservation is more critical than ever, the Swedish company EcoLoc™ is leading the charge with an innovative food-saving solution featuring PureFize® UV technology. A recent study by the Research Institutes of Sweden (RISE) confirms the effectiveness of EcoLoc in significantly prolonging the freshness of food items.

EcoLoc's innovative approach uses PureFize's UV light to treat food, targeting one of the most persistent problems in food storage: mold growth. The RISE study highlights this technology's impressive capability to delay mold on food by up to five days. In a controlled environment, agar substrates inoculated with mold and stored at 8°C demonstrated this delay, showcasing the potential for real-world applications.

Johan Tingsborg of PureFize Technologies remarks on this achievement, "The RISE study not only validates EcoLoc's and thereby PureFize's impact in combating mold, a notoriously resilient microorganism but also emphasizes the broader effectiveness of PureFize technology against other microorganisms like bacteria and viruses."

EcoLoc on Penicillium roquefortii in refrigerator (8°C)

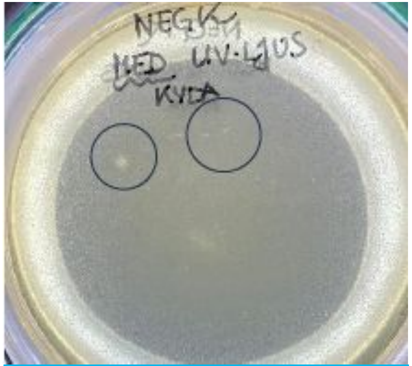
PureFize + refrigeration = improved food freshness

KEEP FOOD FRESH LONGER - REDUCE WASTE - PRESERVE TASTE & QUALITY

Delaying microbial* growth in refrigerator

*Penicillium Roquefortii

3 days
without PureFize



8 days
with PureFize

Study by RISE (Research Institute of Sweden) clearly proves the EcoLoc effect. It took eight days to see any signs of mold on the plate after using EcoLoc, whereas the non treated plate showed clear signs of mold already after three days.

Both samples were stored in a refrigerator at 8° C.

PureFize effect of shelf life

PRESERVES TASTE

PRESERVES NUTRIENTS

Food Type	Temp .	Extend shelf life (ctrl+time extended)	Extend shelf life %
Blueberry	5°C	+ >15 d	100%
Mango (ripe)*	28°C	+ >1-2 d	25-50%
Peach (ripe)*	28°C	+ >2 d	50%
Grapes	28°C	+ >2 d	> 50%
White mushroom	5°C	+ >2 d	25%
Tomato	28°C	+ > 4 d	250-300%
Tomato	5°C	+ > 4 d	80-100%
Chili pepper	28°C	+ >1 d	50%
Bun	28°C	+ >22 d	200%

*) the ripe fruit PureFized lasted longer that the unripe non-PureFized fruit.

Ref. Internal PureFize studies, 2022.

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Commitment to build excellence in food tech through science, market insights, competence and partner collaboration.

PureFize Food Technology Lab in Stockholm

At PureFize Food Technology Lab, we are conducting extensive research and development to improve food storage.

PureFize Food Technology Lab is headed by Dr. Fernando Mendoza, formerly leading the Advanced Development Food Preservation laboratory at Electrolux.

His doctoral work, focused on innovative techniques for quantitatively evaluating food products' color and surface appearance which aligns with PureFize commitment to pioneering in food technology.


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Electrolux
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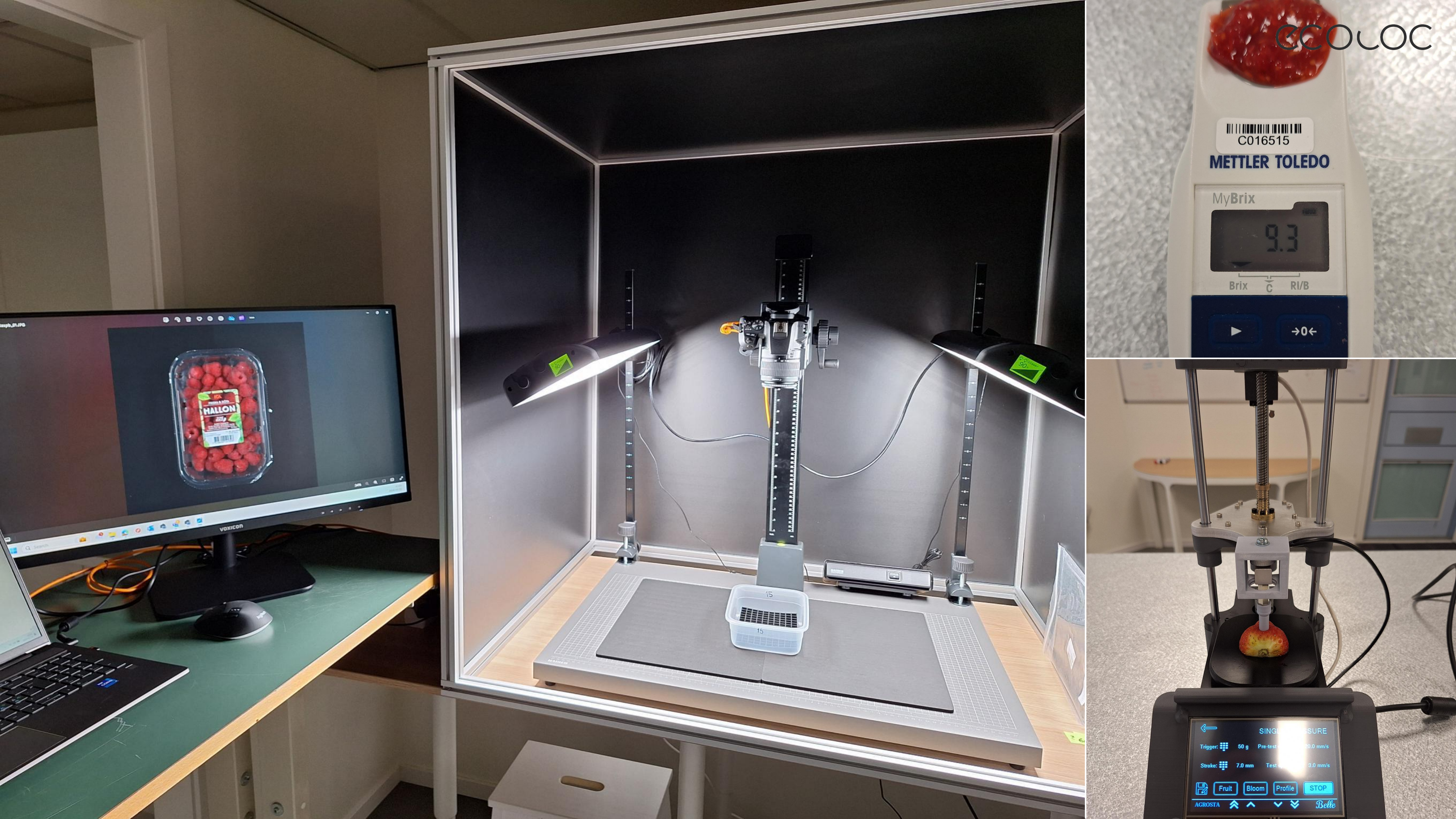

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Bloom
Profile
STOP
AGROSTA
Belle


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TASTELOCK
SNACKZONE
TASTELOCK

PureFize data on certain microbes

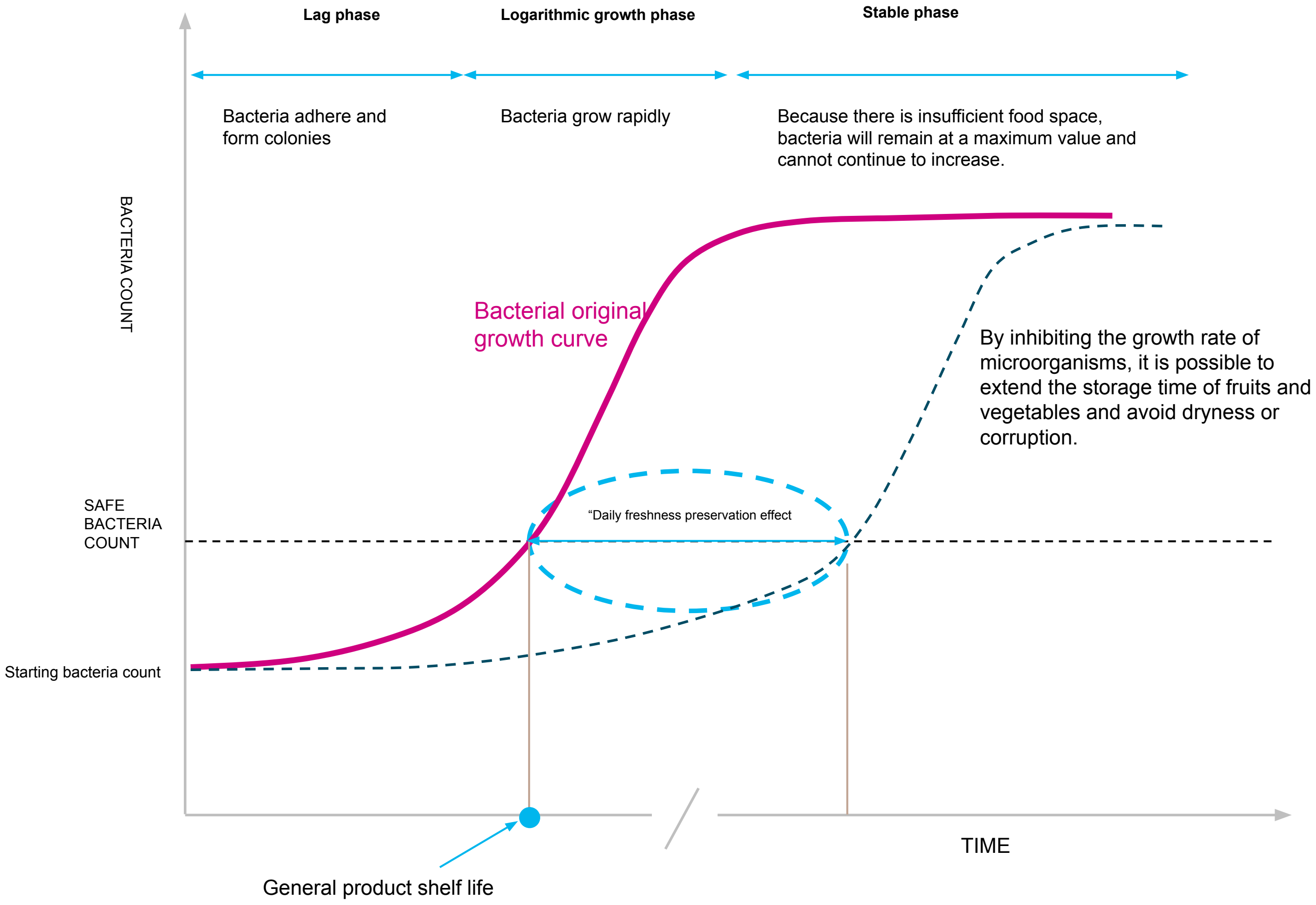
PureFize has been extensively tested on clinically relevant pathogens in our lab and independent laboratories.

Type of test	Institute	Material	Result
Legionella pneumophila	ALS UK	Water	8-log reduction after 60 s
Pseudomonas aeruginosa	ALS UK	Water	7-log reduction after 60 s
Escherichia coli	ALS UK	Water	7-log reduction after 120 s
SARS COV-2	Siena	Surface	6-log reduction after 10 min
Staphylococcus aureus	Eurofins	Surface	3-log reduction after 60 s
Salmonella abony	Eurofins	Surface	3-log reduction after 70 s
Escherichia coli	Eurofins	Surface	3-log reduction after 80 s
Salmonella abony	Eurofins	Surface	3-log reduction after 60 s
Escherichia coli	Eurofins	Surface	3-log reduction after 60 s
Escherichia coli	Eurofins	Water	8-log reduction after 210 s
Escherichia coli	Eurofins	Surface	6-log reduction after 4 min

https://www.purefize.com/the-science-behind/data-and-test-results/

EcoLoc prolonging shelf life

Daily fresh fruits & vegetable preservation concept



PureFize effect on food

The initial studies, being pilot studies as well as more scientifically conducted studies with collaborating partners, were set out to determine the effect of PureFize on foods. It also included determination of UV dose on various kinds of food.

Initial hotdog bread test
The purpose of this test was to see the shelf life of bread with and without PureFize UV disinfection.

For this test hot dog breads without any preservatives were used.

Two pieces of bread were disinfected with PureFize UV disinfection, and two pieces were not disinfected for control purposes.

The disinfection time for each piece of bread was 2 x 5 min.
Five minutes on one side and five minutes on the other side (upside-down) to make sure that all sides and corners of the bread was disinfected.

For comparison: Five minutes of disinfection in the PureFize UV box delivers a 99.9999% reduction of e-coli.

After the PureFize treatment each piece of bread was placed separately in a sealable plastic bags.

The two slices of bread without any treatment were directly placed in plastic bags.

All the plastic bags were cleaned inside with ethanol 70% before breads were inserted.

EcoLoc improving safety

a) Removing germs – avoiding food borne illnesses

b) UVC radiation for food safety

External studies:
Removing germs – avoiding food borne illnesses

Effect of ultraviolet light treatment on microbiological safety and quality of fresh produce: An overview

1. Fresh and fresh-cut fruits and vegetables have been associated in several foodborne illness outbreaks. The concept of hurdle technology involving a sequence of different interventions have been widely explored. Among those interventions, ultraviolet (UV) light alone or in combination with other treatments such as use of organic acids or sanitizer solutions, has found to be a promising approach to maintain the microbiological safety and quality of fresh and fresh-cut produce.
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9356256/

UVC radiation for food safety: An emerging technology for the microbial disinfection of food products

1. UVC approach is an efficient and eco-friendly option for food processing/preservation.
2. UVC light (200–280 nm) possesses excellent germicidal properties to inactivate a wide range of microbial pathogens (e.g., bacteria, fungi, yeasts, molds, and viruses). UVC technology can be used to effectively prevent foodborne illnesses while increasing the shelf life of food without compromising its quality by reducing the microbial load.
3. https://www.sciencedirect.com/science/article/abs/pii/S1385894720342005

Scientific data: UV and food

Food and Drug Administration(FDA) and US Department of Agriculture (USDA) have concluded that the use of UV irradiation is safe.

FDA CFR - Code of Federal Regulations Title 21
https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=179.39

Effect of different doses of UV-C on visual appearance and chlorophyll fluorescence parameters of lettuce
H. Attia et al (2021)

Impact of UV-C radiation on the sensitivity of three strawberry plant cultivars (Fragaria x ananassa) against Botrytis cinereal
M. Forges et al (2018)

Use of low-dose UV-C irradiation to control powdery mildew caused by Podosphaera aphanis on strawberry plants
Wojciech J. Janisiewicz et al (2016)

Preharvest UV-C treatment improves the quality of spinach primary production and postharvest storage
A. Martínez-Sánchez et al (2019)

UV-C treatment promotes quality of early ripening apple fruit by regulating malate metabolizing genes during postharvest storage
J.C. Onik et al (2019)

UV-C Treatments Enhance Antioxidant Activity, Retain Quality and Microbial Safety of Fresh-cut Paprika in MA Storage
In-Lee Choi et al (2015)

Flashes of UV-C light: An innovative method for stimulating plant defenses
J. Aarrouf and L. Urban (2020)

Inactivation of internalized Salmonella Typhimurium in lettuce and green onion using ultraviolet C irradiation and chemical sanitizers
C. Ge et al, (2013)

Other studies proving UV effect on food

a) Improving nutritional value

b) Food

c) UV for food preservation

External studies:
Improving nutritional value

UV-C Light: A Promising Preservation Technology for Vegetable-Based Nonsolid Food Products

1. In studies conducted on nonsolid food, UV-C treatment has been proven to preserve quality and minimize nutrient degradation. This review compiles information on the use of UV-C technology in preserving the nutritional attributes of nonsolid foods derived from fruit and vegetables.
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10486447/

Food

Lettuce and Green Onions

Inactivation of internalized Salmonella Typhimurium in lettuce and green onion using ultraviolet C irradiation and chemical sanitizers, C. Ge et al, (2013)

- Significant reduction in internalized Salmonella was observed in lettuce (1.96–2.52 log CFU/g) and green onion (1.00–1.49 log CFU/g) treated with UV-C.
- https://pubmed.ncbi.nlm.nih.gov/23351161/

Apple

UV-C treatment promotes quality of early ripening apple fruit by regulating malate metabolizing genes during postharvest storage, J.C. Onik et al (2019)

- Early ripening apples exposed to UV-C had enhanced malic acid dehydrogenase activity and reduced concentration of malate (sharp apple flavor) during storage.
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6467447/

Paprika

UV-C Treatments Enhance Antioxidant Activity, Retain Quality and Microbial Safety of Fresh-cut Paprika in MA Storage, In-Lee Choi et al (2015)

- UV-C treatments can enhance antioxidant activity and phenolics, retain firmness and quality, and improve microbial safety of fresh-cut paprika in modified atmosphere storage.
- After 7 days of storage at 8°C, the antioxidant activity (DPPH activity), total phenolic compound and vitamin C contents of fresh-cut paprika were maintained highest by UV-C 15 kJ/m2 treatments.
- https://link.springer.com/article/10.1007/s13580-015-0141-y

Strawberry

Impact of UV-C radiation on the sensitivity of three strawberry plant cultivars (Fragaria x ananassa) against Botrytis cinereal, M. Forges et al (2018)

Use of low-dose UV-C irradiation to control powdery mildew caused by Podosphaera aphanis on strawberry plants, Wojciech J. Janisiewicz et al (2016)

- Exposing strawberry plants to low repeated doses of UV-C (only significant at the doses of 0.85 kJ/m^2 and 1.70 kJ/m^2 applied on strawberry plants every two days for one week) could improve their resistance against gray mold (B. cinereal), while avoiding any apparent negative effects to the plants.
- Strawberry plants treated once a week with 60 s exposure to UV-C (21mW/m2) could eliminate mildew caused by Podosphera aphanis.
- Once a week for 3 weeks resulted in more than a 4x reduction of conidial production on adaxial leaf surfaces exposed to the UV-C irradiation and did not affect leaf photosynthesis. The UV-C treatment of plants over 15 weeks reduced the amount of diseased fruit and increased fruit yield and quality.
- https://www.sciencedirect.com/science/article/abs/pii/S0304423818304552
- https://www.tandfonline.com/doi/full/10.1080/07060661.2016.1263807

Frozen Raspberry

Inactivation of Listeria monocytogenes on Frozen Red Raspberries by Using UV-C Light, Yente Liao et al (2017)

- UV-C light can reduce the L. monocytogenes population on frozen raspberries.
- No significant differences in total anthocyanins, total phenolics, and total antioxidant activity were observed between UV-C-treated and untreated frozen berries immediately after treatment.
- At the end of 9 months of storage at -35°C, UV-C-treated berries had statistically lower total phenolics, higher total anthocyanins, and similar total antioxidant activity compared with untreated berries.
- https://pubmed.ncbi.nlm.nih.gov/28272923/

Ultraviolet-C light sanitization of English cucumber (Cucumis sativus) packaged in polyethylene film

Results show that UV light treatment delayed the loss of firmness and yellowing of English cucumber up to 28 day at 5°C.

- UV light treatment, delayed the loss of firmness and yellowing of cucumber up to 28 days at 5 °C and extended the shelf life of treated cucumber 1 week longer compared to untreated cucumbers by influencing the morphology of the E. coli k-12 cells.
- https://pubmed.ncbi.nlm.nih.gov/27097058/

UV for food preservation

List of microorganisms commonly found in food products

Table 1
List of microorganisms commonly found in products: (A) Pathogenic microorganisms that contaminate food items and their associated disorders; and (B) Spoilage microorganisms and their effects on food quality.

A. Pathogenic microorganisms				Reference
Order	Microorganism	Food item/product	Associated symptoms/disorders	
1.	*Escherichia coli*	Liquid foods such as fruit juices, alcoholic beverages, and milk; raw meat; bees; fresh produce, including raw fruits and uncooked vegetables.	Hemorrhagic diarrhea, abdominal cramping, pain or tenderness, nausea and vomiting, kidney failure, urinary infections.	[138–140]
2.	*Bacillus* spp. *(B. subtilis, B. cereus, B. anthracis)*	Milk and milk products, eggs, meat products, uncooked chicken, seafood, spices, vegetables, grains (rice, etc.).	Gastrointestinal illness, vomiting, diarrhea, abdominal cramps, etc.	[141,142]
3.	*L. monocytogenes*	Unpasteurized milk and dairy products, soft cheeses, ready-to-eat deli meats, and refrigerated seafoods.	Invasive listeriosis, fever, diarrhea, fatigue, and muscle aches.	[143,144]
4.	*Campylobacter* spp. *(C. jejuni)*	Unpasteurized milk and fruit juices, chicken, shellfish, turkey, contaminated water.	Diarrhea, cramps, fever, vomiting, and bloody diarrhea.	[145–147]
5.	*Clostridium* spp. *(Cl. perfringens, Cl. botulinum, Cl. tetani)*	Honey, fish, meats, vegetables, infant foods, green beans, soups, beets, asparagus, mushrooms, ripe olives, etc.	Neurological signs, including visual impairment and acute flaccid paralysis, nausea, and vomiting.	[148,149]
6.	*Salmonella* spp., *Shigella* spp.	Contaminated poultry meat, cheese, raw fruits and vegetables, ready-to-eat products, etc.	Enteric infections, malaise, headache, fever, cough, nausea, vomiting, constipation, abdominal pain, chills, rose spots, bloody stools, etc.	[150–152]
7.	*Staphylococcus aureus*	Raw retail meat, milk and dairy products, etc.	Nausea, vomiting, retching, diarrhea, abdominal pain, prostration, bacteremia, pneumonia, osteomyelitis, cerebritis, and meningitis.	[153–155]
8.	*Cronobacter sakazakii*	Dried milk powder, dried meats, legumes, nuts, dried flours, and spices	Infant septicemia, meningitis, necrotizing enterocolitis, stomach pain, can affect cerebral ventricles and cause brain abscesses in neonates.	[156,157]
9.	*Yersinia enterocolitica*	Raw milk, seafood, etc.	Watery stools or bloody diarrhea with fever, vomiting, and abdominal pain, septicemia, meningitis, Reiter syndrome, myocarditis, glomerulonephritis, thyroiditis, and erythema nodosum.	[152,158]
10.	*Hepatitis virus and norovirus*	Raw or undercooked shellfish, raw produce, uncooked foods, etc.	Gastroenteritis, enterically transmitted hepatitis, nausea, vomiting, watery non-bloody diarrhea, dehydration, dark urine or light-colored stools, jaundice, low grade fever, etc.	[159–161]
B. Spoilage microorganisms				
Order	**Microorganism**	**Food item/product**	**Associated effects**	
11.	**Spoilage bacteria:** *Alicyclobacillus acidoterrestris, Lactic acid bacteria (Lactobacillus plantarum), Brochothrix thermosphacta*, and *Pseudomonas* spp.	Acidic fruit or vegetable juices, bread, sausage, raw fish and other seafood, pickles, poultry, etc.	Food deteriorates from its original organoleptic properties; changes in odor, texture, and appearance; consumption of contaminated food can cause serious health problems and huge economic losses to both producers (farmers) and consumers.	[162,163]
12.	**Spoilage yeasts:** *Saccharomyces cerevisiae, Candida* spp., *Dekkera* spp.	Low-acid foods, bakery products, jam, jellies, beverages, salt brine products, wine, etc.	Production of gas, off flavors, and turbidity in foods.	[164,165]
13.	**Spoilage molds:** *A. flavus A. niger Byssochlamys*	Canned fruit juices, highly sugared foods, cereals, nuts, eggs, dairy, etc.	Visual defects, gas production, etc.	[166–168]

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A list of major studies on UV radiation-assisted microbial inactivation on fresh produce

Order	Food product processed	Target microbes	UVC treatment conditions/parameters				Reference
			UVC source/ UV reactor configuration	Wavelength	UVC dose (mJ cm^{-2})/(J m^{-2}) UVC irradiance (W m^2) UVC flow rate (J ml^{-1})	Combination technique used along with UVC treatment (if any)	
1.	Apricots	*E. coli* O157:H7 and *Salmonella* spp.	Custom-built UV treatment chamber	254 nm	442 mJ cm^{-2}	–	[257]
2.	Pomegranate arils	Browning enzymes	Philips unfiltered germicidal emitting lamps	254 nm	4.54 kJ m^{-2}	Mild heat and super-atmospheric oxygen	[258]
3.	Button mushroom	*E. coli* H157:O7 and native microflora	UVC irradiator containing four UVC emitting bulbs	254 nm	0.45 kJ m^{-2}	H_2O_2	[259]
4.	Date palm	Mesophilic bacteria, coliforms, yeasts, and molds	Philips unfiltered germicidal emitting lamps	254 nm	6.22 kJ m^{-2}	Ozone and electrolyzed water	[260]
5.	Organic fruits (apples, pears, strawberries, etc.)	*E. coli* O157:H7 and *L. monocytogenes*	UVC Emitter™ table-top system	254 nm	11.9 kJ m^{-2}	–	[261]
6.	Organic fruits	*P. expansum*	UVC Emitter™ table-top system	254 nm	0.13 – 3.3 kJ m^{-2}	–	[262]
7.	Fresh blueberries	Murine norovirus	Water-assisted UVC system containing four UV lamps	254 nm	12,000 J m^{-2}	–	[263]
8.	Fresh hybrid broccoli	*E. coli*, *S. enteritidis*, and *L. monocytogenes*	UVC chamber with 15 unfiltered germicidal emitting lamps	254 nm	0 to 15 kJ m^{-2}	–	[264]
9.	Packaged pineapple sticks	*Enterobacteriaceae*, lactic acid bacteria, yeasts, and molds	Four UVC lamps	254 nm	200 J m^{-2}	–	[265]
10.	Cauliflower	*L. monocytogenes*, *E. coli* O157: H7, and total yeasts/molds	F300S UV lamp system	254 nm	5–10 kJ m^{-2}	Gamma radiation	[266]
11.	Gallic acid in food products	*E. coli* O157:H7	Spectroline bench-top UVC chamber	254 nm	4 J cm^{-2}	–	[131]
12.	Spinach & food media	*E. coli O157:H7*, *S. Typhimurium*, and *L. monocytogenes*	16 UVC LEDs in a module system	254 nm	7.26 mJ cm^{-2}	–	[122]
13.	Lettuce leaves Apple skin	*E. coli*, *S. typhimurium*, and *L. monocytogenes*	Low-pressure mercury lamps and UVC LEDs	254 nm 277 nm	500 mJ cm^{-2}	–	[267]
14.	Fresh cut strawberries	Mesophilic bacteria, molds, and yeasts	Three germicidal UVC lamps	254 nm	3.8 – 7.5 kJ m^{-2}	Combined with orange juice	[268]
15.	Black peppercorns	*Salmonella* spp.	Five UVC lamps	254 nm	616 μW cm^{-2}	Cold plasma	[269]

List of important research on UV based microbial inactivation in meat products

Order	Food product processed	Target microbes	UVC treatment conditions/parameters				Reference
			UVC source/ UV reactor configuration	Wavelength	UVC dose ($mJ\ cm^{-2}$)/ ($J\ m^{-2}$) UVC irradiance ($W\ m^{2}$) UVC flow rate ($J\ ml^{-1}$)	Combination technique used along with UVC treatment (if any)	
1.	Cooked ham and bologna	*L. monocytogenes*	Pulsed light treatment (3–4 pulses per minute)	UVA, UVB, and UVC	8.4 $J\ cm^{-2}$	–	[244]
2.	Beef-agar food	*L. monocytogenes*	UVC treatment chamber	254 nm	195 $mJ\ cm^{-2}$	–	[245]
3.	Sliced fermented salami meat	*E. coli* O157:H7, *S. typhimurium*, and *L. monocytogenes*	Pulsed UV light treatment	200–1,100 nm	3–15 $J\ cm^{-2}$	–	[246]
4.	Chicken thigh meat	*Salmonella*, *E. coli*, and *Campylobacter*	Pulsed UV light treatment	200–1,100 nm	1.27 $J\ cm^{-2}$	–	[247,248]
5.	Pork	*Y. enterocolitica* and *B. thermosphacta*	UV-Cabinet	253.7 nm	16.16 – 19 $mJ\ cm^{-2}$	–	[249]
6.	Ground beef	*Salmonella* spp.	UVC emitters	254 nm	800 μWcm^{-2}	–	[250]
7.	Goat meat surfaces	*E. coli* O157:H7	Spectrolinker, XL-1500 UV system	254 nm	0.2–2.4 $mJ\ cm^{-2}$	Lemongrass oil	[251]
8.	Chicken fillets	*S. enteritidis*, *L. monocytogenes*, *S. aureus*, *enterohemorrhagic E. coli*, *Pseudomonas* spp., *B. thermosphacta*, and *C. divergens*	Two UVC lamps	253.7 nm	0.05 – 3 $J\ cm^{-2}$	–	[252]
9.	Caiman (*Caiman crocodilus yacare*) meat	*Salmonella* spp.	UVC equipment containing six lamps of 30 W and six lamps of 55 W	254 nm	0.105 – 0.199 $J\ cm^{-2}$	–	[253]
10.	Frankfurter sausages, sliced boiled ham, and chicken cold cuts	*L. inocua*	Pulsed UV chamber with three xenon lamps	200–1,100 nm	0.35 to 1.20 $J\ cm^{-2}$	–	[254]
11.	Sliced deli meat	*E. coli O157:H7*, *S. typhimurium*, and *L. monocytogenes*	16 UVC LEDs in a module system	254 nm	7.26 $mJ\ cm^{-2}$	–	[122]
12.	Goat meat and beef surfaces	*E. coli K12*	Pulsed UV light modular sterilization system	200 – 320 nm	1.27 J cm-2	–	[255]
13.	Beef, chicken, and pork	*E. coli* and *S. aureus*	Mercury low-pressure vapor lamps	254 nm	5–15 $J\ cm^{-2}$	Curcumin-mediated photodynamic inactivation	[256]