Clean Label Shelf-Life Extension: UV Light Treatment

Now more than ever, consumers are demanding tasty, safe, healthier, organic, clean-label, and fresh food products produced in an environmentally friendly manner using sustainable, minimally processed, and with smaller carbon footprints. Companies that succeed at attracting customers through creating a clean label solution will be at the leading edge of innovation.

Using UV technology for shelf life provides this leading edge for bakers. It is a green technology that leaves no chemical residues after its application and has little to no effect on the organoleptic properties of the product. This is why UV light treatment of food has emerged as a great alternative, even as an additional food preservation step. It works to help manufacturers extend the microbial shelf-life of products while navigating the complex road of clean-label reformulation.

Regardless of whether one is baking on an industrial scale or following artisanal methods, water plays a crucial role in the bread-making process—especially during the formation of dough. Unfortunately, due to the high amount of water (38%) left in bread after baking, it is a great medium for mold growth.[12]

What is Shelf Life?

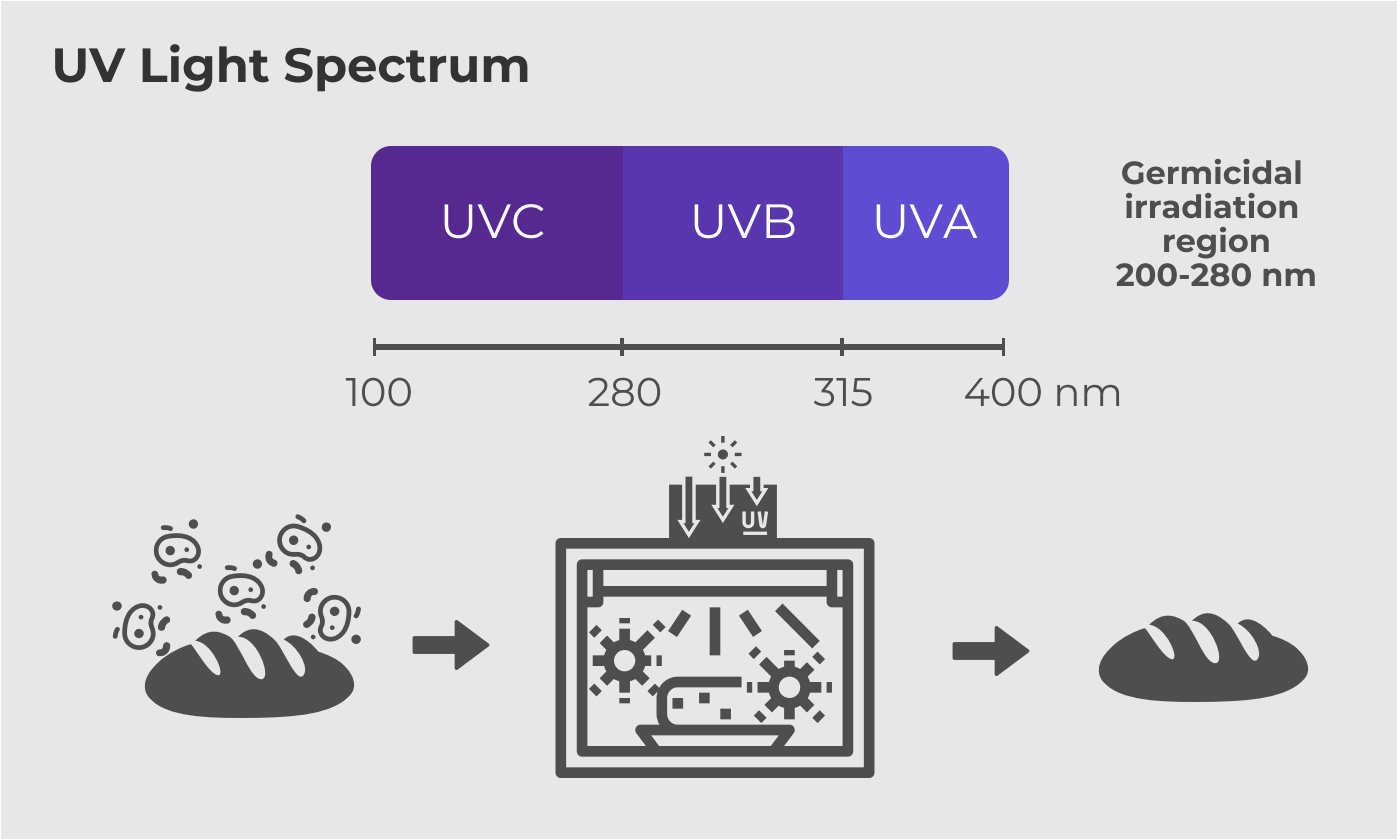
A product's shelf life is the expected amount of time that the product maintains its ideal organoleptic properties for consumption while satisfying consumers' expectations or the product maintains its safety for consumption properties (e.g., spoilage or microbial contamination). Usually, a product shelf life can be determined by two main factors: a) loss of organoleptic quality or b) loss of microbial stability.[1]

This can be determined by some organoleptic properties such as texture, appearance, or odor, or by microbiological assessment of deteriorating or pathogenic microorganisms. Staling is the process that baked goods undergo due to the loss of moisture. This causes undesirable textural changes in the product resulting in a dry, firm, and less palatable baked good. Staling is caused by starch retrogradation due to the reorganization of starch molecules. This process may make the product non-palatable but it does not render the product unsafe for consumption, like a microbial contamination would.[1]

Food safety must consider a wide variety of potential hazards, which are usually classified into three main groups: biological, physical, and chemical hazards. Several measurements can be taken to prevent these hazards and are commonly placed in industrial settings where food safety is one of the main priorities, from thermal processing to novel technologies such as UV light treatment for food product disinfection.

What is the UV Light Treatment of Baked Goods?

Ultraviolet (UV) light treatment of baked goods involves the exposure of bakery products, prior to packaging, to a field of ultraviolet light radiation having a wavelength between 200 – 280 nm corresponding to the UV-C region of germicidal irradiation.[1]



UV light treatment of foods is an FDA-approved technology that can be used for decontamination of food-contact surfaces and lowering the microbial load of food. It is a non-thermal method, which means that this technology does not involve heating or cooling of the product, which may cause the loss of some quality properties (e.g., color, texture, aroma, etc.) like conventional heat treatments.[2]

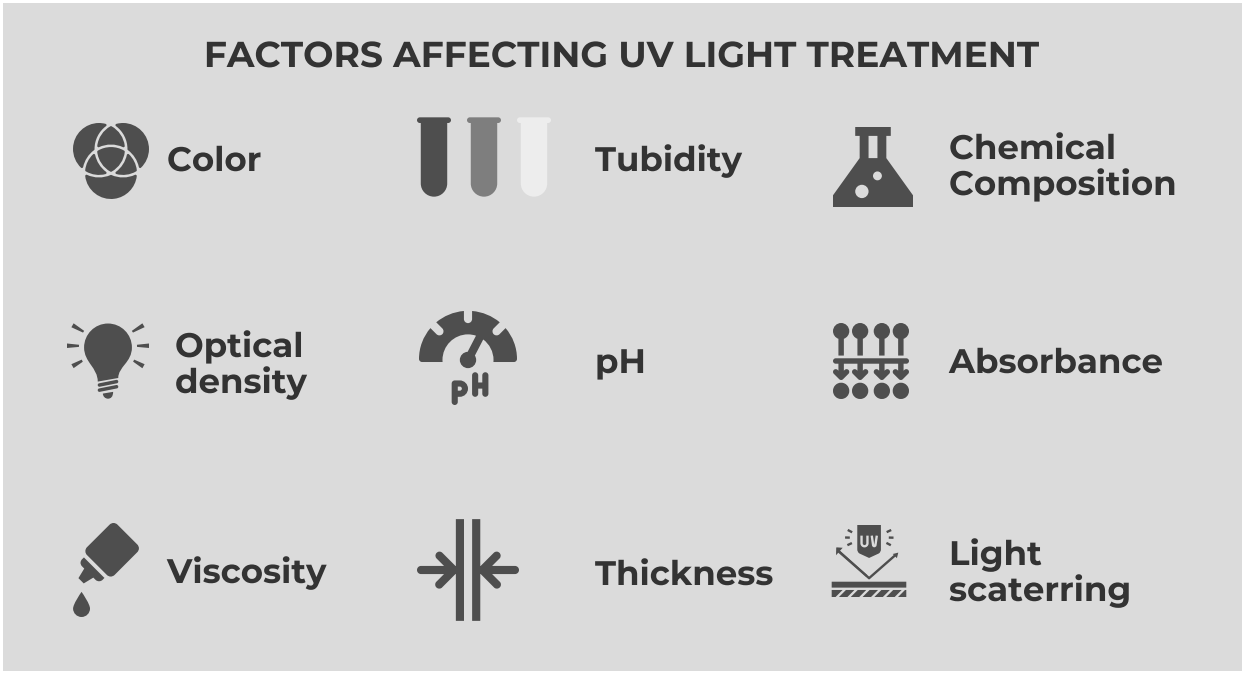
This treatment can be used in bakeries for several purposes such as sanitizing contact surfaces, processing water (e.g., water as an ingredient), packaging, air, and the product itself on some occasions.

Most contamination of bakery products occurs after baking in the succeeding production steps such as: cooling, slicing, transportation, and packaging. So, those are the key steps to be controlled and the use of UV light technologies may help remove or reduce the potential hazards of microbial contamination.[3]

How Did it All Start?

Compared to water treatments, air disinfection, and surface decontamination, the application of UV light for processing food products is a relatively new and challenging area. In 2001, the FDA approved UV light irradiation at 253.7 nm for application in bottled water, juice, and soft drinks processing, although the specified dosage time is not stated in the 21 CFR 179.39. The FDA recommends that the dosage criteria should be determined for each food product for each situation while following good manufacturing practices.[4,5]

The development of effective UV treatments for solid food applications requires alternative approaches to those normally employed for water or air treatment. This is due to a wide variety of food product parameters that intervene in the efficiency of UV light as a disinfectant method such as: color, optical density, viscosity, turbidity, pH, thickness, chemical composition, absorbance, and light scattering. The last two, absorption and scattering of light, are significantly higher in food products (e.g., juice and fresh produce) than in water or air.[1]



In UV light treatments of a food product, UV light is absorbed by most materials and cannot penetrate beyond the surface layers of solid objects. Therefore, it is only microorganisms that are present at the surface that will be destroyed considering the aforementioned parameters. This surface treatment on baked goods is highly effective in most bakery applications.

How Does it Work?

In baked goods applications, UV light technology must be adapted and installed properly. As with other food products, dosage and treatment time needs to be determined at the facility by conducting an efficiency test that shows the reduction of microbial load.[1]

TIP: High volume UVC treatment involves continuous-type production lines. For tortillas, use an output rate of 200 to 400 pieces per minute. For pan bread an output rate of 90 to 180 pieces per minute is recommended.

The UV light preservation technology system for high-speed lines usually involves the following 6 components:

1. Sanitary design conveyor belt (online setup)
2. Stainless steel enclosure that isolates the radiation chamber and product-contact surfaces to guarantee operators' safety
3. Shatterproof UV lamps or UV LEDs
4. 240 V electrical wiring
5. LEDs shielding for foreign material contamination prevention
6. Industrial control panel to monitor and control related equipment
7. HMI for recipe selection and parameters setup

Research & Scientific Concepts About UV Light Treatment of Food Products

The success of UV light technology as an alternative to pasteurization or conventional shelf-life extension methods depends on several factors, which include the following: [1]

- Physico-chemical properties of the food (optical absorption coefficient, density, acidity, dissolved solids, water activity)
- Composition of food products to be treated
- Characteristics and the correct choice of UV radiation (light emitting source)
- Number of UV lamps or UV light-emitting diodes (UV LEDs)
- Exposure time to UV rays (mostly around 15 seconds or more depending on dosage and type of UV treatment)
- Specific power in watts of each UV lamp or LED
- Correct positioning of light emitting sources to direct UV rays onto the product surface
- Product surface topography and 3D shape (ideally, the surface should be as flat and smooth as possible for UV light to be superficially lethal)
- Microbial efficiency against pathogenic and load reduction of spoilage organisms
- Effects on quality, enzymes, nutrients content, and sensory attributes
- Commercial and economic aspects including process validation and regulatory approvals depending on the country / local laws

Food loss is one of the main challenges food producers face. Around 40% of all food produced around the globe is wasted. Around 7% is disposed of in retail and food service, 8% is lost at the farm or slaughter, 11% at the household, and 14% during transportation rounding up to around 40% of all food produced.[6]

In bakeries, around 20% of baked products are lost in large bakeries mainly due to returns from retailers, while 1.5% of product losses are generated in small-scale bakeries.[7]

Three main categories of food losses can be identified in the baking industry, starting from the farm or production level where most of the losses can be associated with damage caused by insects, rodents, or microbes and by spoilage or damage during transportation. At the retail and consumer levels, most of the losses that occurred were due to inadequate storage or transportation, and overbuying that may cause the ultimate disposal of the product after its best-by date of consumption[7]

To combat food waste or food loss in the baking industry several measures are being taken—from the usage of more adequate packaging solutions to better control of storage and transportation facilities, as well as reformulation to extend product shelf-life.

However, current health trends have caused a shift in consumers' expectations regarding the formulation of everyday food products. Consumers now expect clean-label solutions and are moving away from calcium propionates and potassium sorbates. UV light presents itself as a novel technique for its use as a clean-label method to extend the shelf life of baked goods.

Results from applied research done at the FDA indicate that exposure of foods to UV intensities of 5 – 10 mW/cm^2 , provides a total dose of 0.5 - 1.0 J/cm^2 , can inactivate 0.5 to 3.5 log10 of foodborne pathogens on food product surfaces, depending on the food's surface topology.[2]

A research conducted by Kim and Hung determined that UV-C light irradiation treatment was more effective in reducing E. coli O157:H7 on blueberries compared ozone treatments. E. coli O157:H7 was reduced by 1.5-2.1 log CFU/g on blueberry calyx and 3.1 to 5.5 log CFU/g on the blueberry skin following application of a dose of 1.2–12 J/cm^2 of UV-C irradiation.[8]

A study conducted in 2015 on UV-C irradiated lemon–melon juice mix by Kaya et al. with a UV-C dose of 0.44 to 2.86 J/mL, found that the shelf-life of the juice increased from 2 to 30 days, with very little significant changes in the physicochemical characteristics of the juice, except on the product turbidity.[9]

A par-baked pizza UV treated for prevention of mold growth analysis was conducted in Canada. It obtained a shelf life up to 40 days shelf-life extension. Samples treated with a voltage of 1,000 V showed a steady surviving population of less than 102 CFU/g over the storage time in 21 days.[10]

A Belgian university study obtained an increase in the shelf-life of wholemeal, rye, and six-grain bread from 5 to 6, 8, and 9 days, respectively, using a dosage of UV-C radiation of 2.50 J/cm^2.[11]

Is food treated by UV rays safe for consumption?

UVC-based food disinfection does not produce any chemical residues or toxic by-products, according to several scientific reviews. In some cases, it may even improve the product's nutritional content. UV light technology in food is approved by the U.S. Food and Drug Administration under 21 CFR 179.39 “Ultraviolet radiation for the processing and treatment of food.” This law specifies the same application of UV rays and limits radiation intensity. In the European Union, UV light technology use in food is also an approved method during food production steps, particularly to increase vitamin D2 content in bread for the purpose of increasing the product's nutritional value.[4,12]

At Dinies North America we are pioneering the way we treat the food we eat. UVC has been widely used for many years to treat our water and air, but less so in food processing. By using this chemical-free and byproduct-free technology, we can effectively use UVC as an antimicrobial kill step, and shelf life extender. Learn more about what's possible here.

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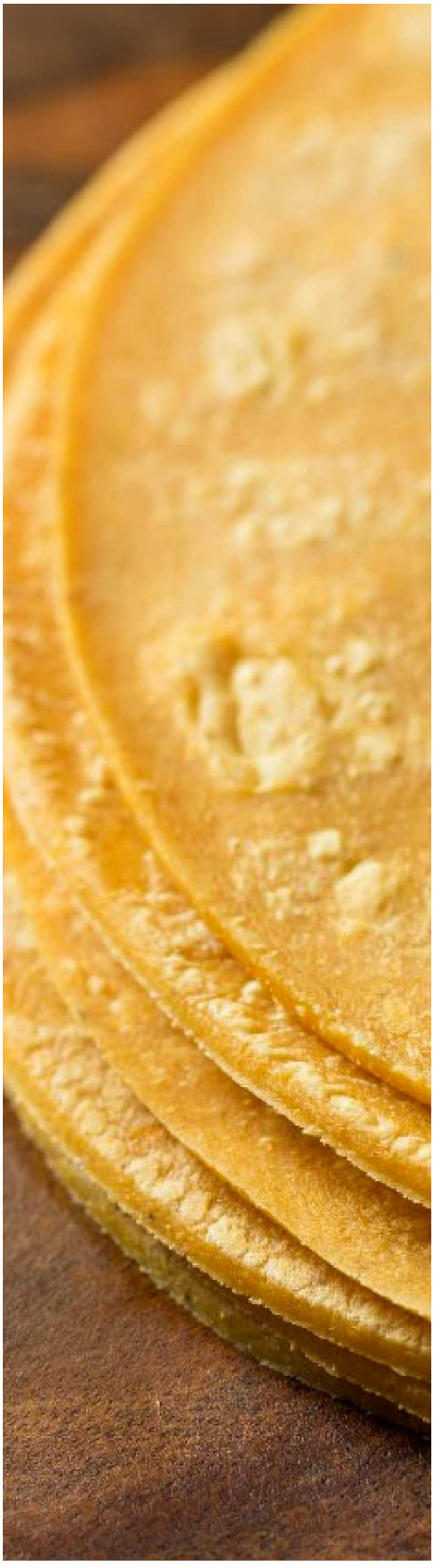

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