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Short Communication

Ultraviolet light food processing: A mini concept

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Abstract

Chemical preservatives, which are added to food to increase shelf life and to guard against diseases that can spread through food borne bacteria, are drawing an increasing amount of criticism from the general public. Alternatives to present preservation methods are being sought to meet customer desires for healthier meals. In contrast to conventional heat processing, ultraviolet light has great promise in the field of food processing. Just a few of its applications include pasteurizing juices, post-lethality treating of meats, treating surfaces in touch with food and increasing the shelf life of fresh vegetables. A brief assessment of the working of UV light and its applications is done in this review. In specific this review work highlights the potential application of ultraviolet as an alternative means of preservation of food.

Keywords food processing, pasteurization, shelf life, ultraviolet

Introduction

Chemical preservatives, which are added to food to increase shelf life - affected by spoilage bacteria - and also to guard against diseases that can spread through food, draws criticism from consumers. Thus alternatives to present preservation methods are being looked in order to meet customer desires for healthier meals. The food industries are interested in ultraviolet light as a physical preservation technique because it is independent of thermal treatment and has a favourable reputation with consumers. In place of conventional thermal processing, ultraviolet light processing is employed to increase shelf life of fresh foods as well as liquid meals including beverages like soft drinks and fresh juices. This use of ultraviolet light from the electromagnetic spectrum to kill microbes in food is known as "ultraviolet processing" [1-3]. Electromagnetic spectrum wavelengths for ultraviolet processing are typically classified into the following four groups.

1. Ultraviolet -A (315-400 nm): It is responsible for the tanning process, which alters human skin.
2. Ultraviolet -B (280-315 nm): It is responsible for skin cancer.
3. Ultraviolet-C (200-280 nm): This range of UV light is referred to as germicidal range and is effective for virus and bacterial inactivation. Within a few hundred meters, the air absorbs UV-C almost entirely. Ozone is created as a result of the energy exchange when UV-C photons hit oxygen atoms. Due to its rapid absorption, Ultraviolet C is seldom ever seen in the natural world [4]. The vacuum ultraviolet range

(100-200 nm). In this range, UV light can only be communicated in a vacuum because it can be absorbed by practically all things and thus is not much useful in decontamination in atmospheric conditions.

Sources of ultraviolet light

(a). The majority of ultraviolet-based disinfection systems conventionally use low and medium-pressure mercury lamps as their main radiation sources. These are basically gas discharge lamps. The mercury vapour pressure that exists when the lamps are in use is the foundation for these definitions. The most widely used ultraviolet lamps are of low pressure type.
(b). Incandescent lamps can also be used as a cheap UV source in a laboratory setup. This type of source uses halogen lamps with coating on the bulb surface to absorb all light except UV and as a result ratio of input energy converted to UV light remains low.
(c). Ultraviolet LED lights are becoming viable options since LEDs provide affordable and high energy efficiency UV generation. Their limitation is that only specific wavelengths are available cheaply. For example, 395 nm UV LEDs are very common.
(d). Ultra violates gas lasers are another source of pure UV light. This kind of source can be manufactured to produce UV light at any desired wavelength.

Mechanisms of microbial inactivation by ultraviolet light

By destroying microbial nucleic acid, ultraviolet radiation renders bacteria inactive and stops them from reproducing. Nucleic acid can be either ribonucleic acid or deoxyribonucleic acid and both are affected by UV light. To better understand the mechanism, it must be stated that double-stranded DNA makes up the nucleus in the majority of cells except for viruses which can use single strands of DNA or RNA. To produce metabolic activity within the cell, ribosomal, transfer, and messenger RNAs use information from DNA. Thus wherever life is present, DNA and RNA are present and UV light can affect them.

DNA and RNA are long polymers that are constructed from combinations of four nucleotides. The purines adenine and guanine, as well as the pyrimidines thymine and cytosine, are the nucleotides found in DNA. The purines adenine and guanine, as well as the pyrimidines uracil and cytosine, are the nucleotides of RNA. Nucleotides on one strand of the double-stranded nucleic acid complement those on the other strand. In both DNA and RNA, guanine pairs with cytosine but in DNA adenine pairs with thymine while in RNA adenine pairs with uracil. Each pair is stabilized by hydrogen bonds. But in presence of UV light pyrimidine nucleotides on the same DNA or RNA can form dimers, disrupting normal DNA. Further, each nucleotide in DNA or RNA is composed of a nitrogenous base nucleic acid and a sugar phosphate that absorb Ultraviolet light between 200 and 310 nm. Thus microorganisms are universally destroyed by ultraviolet radiation due to damage to their DNA or RNA structures [1, 4-6].

Advantages of ultraviolet light processing

Ultraviolet disinfection is superior to other techniques in several ways.
(a). Since ultraviolet treatment is a non-thermal preservation technique, it has the benefit of producing neither hazardous nor significantly toxic byproducts.
(b). Relative to thermal pasteurization methods, very little energy is needed.
(c). The fruits and other flavorful commodities treated with the treatment still retain their full aroma and colour [7].
(d). Contrary to chemical treatment, ultraviolet light does not add residues to the process and, does not change the pH, taste, odour of the commodity treated [8].
(e). Treatment cost of UV processing is not very high as the production of UV light is cheap and exposure to UV light is a relatively simple process.

(f). UV treatment is instant and thus long holding time under UV treatment is not necessary.

Limitations of ultraviolet light processing

(a). Ultraviolet is primarily helpful for surface cleaning such as fresh fruit surfaces and for disinfecting liquids that are partially transparent to ultraviolet light. Although ultraviolet light is electromagnetic wave, its ability to penetrate opaque materials is only partially effective at UV wavelengths [9-10].
(b). It is impossible to treat opaque liquids in laminar flow due to the low penetration of ultraviolet light into the product. However, by creating a highly turbulent flow, it is possible to achieve treatment homogeneity due to the constant mixing of liquid and exposure of the new surface to UV light.
(c). Surface effects only, and challenging to employ on complicated surfaces [11].
(d). Not demonstrated to work against spores.
(e). Some microorganisms may be resistant to UV light due to rapid DNA and RNA repair mechanisms present in such organisms [12].
(f). Equipment dependability must be determined.

Applications

There are various applications of ultraviolet light in food processing and some vital ones are discussed below:

Disinfection of surfaces

Although ultraviolet light is more effective only at disinfecting smooth surfaces, it is widely used in the food processing technology sector. UV light is used for sterilizing equipment surfaces in bakeries, cheese and meat processing plants, and other facilities as well as belts of conveyors, and packaging materials such as tubes, foils, bottles, caps, cartons, and boxes. It is also used to surface disinfection treatment of whole and fresh cut fruits, eggs shells, broiler breast fillets, ready to eat meats and baguettes [13-14].

Ultraviolet light for beverages and liquid foods

Ultraviolet light has significant potential in reducing microbial load in a variety of liquid meals and beverages. Among these liquids and other things are pharmaceuticals, industrial lubricants, brines, juices, liquid sugars, and other semitransparent and opaque parts of foods. Since colourants, organic solutes, and suspended debris typically exist in liquid meals, the Ultraviolet pasteurization process is less effective as a result of the poor ultraviolet light transmission in liquid meals. Juices containing pulp have a much lower absorptivity and higher turbidity than clear, fresh juices. Low absorptivity can also be found in clear apple juice. Furthermore, it is challenging to effectively use ultraviolet radiation to treat food commodities due to the wide variations in °Brix (soluble solids concentration), pH, and viscosities. Considering it from a business angle, an increase in viscosity greatly raises the amount of energy needed to uphold the distinct and desired fluid flow properties of the various reactor designs. This implies that in order to satisfy the necessary pasteurisation requirement for a reduction in the quantity of the pathogen that fresh juices should be concerned about, a combination of physical qualities, such as liquid density and viscosity, must be taken into account. The right amount of ultraviolet light exposure or ultraviolet reactor time should be used to sufficiently inactivate bacteria. Examples of commodities which are UV treated are fresh apple juice/cider, low-viscosity juices with pulp, liquid sugars and sweeteners, and liquid egg products [15-16].

Conclusion

Food safety is the major challenge facing the food processing industries worldwide. Promoting food safety and upholding hygienic standards for good health require effective control of pathogenic and spoilage microorganisms in food items. In the era of novel non-thermal preservation techniques, ultraviolet light plays a very important role in the food processing sector. It is an economical and environmentally friendly technology and does not produce any chemical residues and toxic by-products. Fresh food products such as fruits, vegetables, milk, and meat are quite vulnerable to microbial deterioration and enzymatic reactions. These biotic factors not only degrade the nutritional quality but also hampers the acceptability of the food among consumers. Studies reveal that ultraviolet light treatment is beneficial in lowering pathogen load not only in fresh food commodities but also processed food products such as juice, coconut water, soymilk, coconut milk, egg yolk and egg white and thus improving their keeping quality. Despite the fact that UV based techniques have a number of benefits, some disadvantages may prevent their widespread use in food processing. But continuous research and development may counter these limitations and play a very important role in providing safe and wholesome food to the society.

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