The U.S. Food and Drug Administration announced an amendment of the food additive regulations (21 CFR Part 179) for the safe use of UV light to reduce levels of human pathogens and other microorganisms in juice products. This final rule became effective November 29, 2000. This action was in response to a food additive petition filed by California Day Fresh Foods, Inc submitted in May 1999.

According to section 201(s), a source of radiation is used to process or treat food to affect the characteristics of the food. In the subject of the petition, the intended technical effect was a change in the microbial load of human pathogens in juice products. Processors subject to the performance standard (i.e., a five-log pathogen reduction) still must validate their system to show they achieve desired the standard.

BACKGROUND

Several outbreaks of E. coli O157 in juice across the USA and Canada caused FDA to propose regulations requiring the processing of apple cider and other fruit juices prior to consumption. Until now, the only suitable processing technique available has been thermal pasteurization. Heat-pasteurized juices experience substantial changes in flavor and nutritional content. In response to processing limitations of heat treatments, UV light treatment was recommended. Preliminary evidence suggests that UV treatment conserves more of a juice's fresh attributes.

Ultraviolet light (UV) is the term given to that portion of the electromagnetic spectrum, which lies between visible light and X-rays in the region between 100 and 380 nm. UV wavelengths in the vicinity of 280 nm are the most effective for inactivating microorganisms and are referred as "germicidal". Germicidal UV wavelengths are capable of inducing widespread damage in cells including DNA because they coincide closely to the peak of DNA absorptivity.

Two competing mechanisms occur when a microbial cell is irradiated with UV. On the one hand, there are the forces of destruction, which manifest themselves by the formation of the photo-products at a rate depending on the intensity of irradiation. On the other hand, there are the forces of restoration, the repair mechanisms of cell, operating at rates determined by a number of external and internal parameters. If the former exceed the latter, cell inactivation ensues, whereas if the reverse happens the microorganism survives.

There are a number of commercially produced sources which emit energy in the UV-range. These include mercury vapor, metal halide, antimony and xenon sources. Low-pressure mercury sources provide a high efficiency in inactivating cells and a number of other advantages. They emit most of their UV-energy at 253.7 nm, they are relatively cheap, they have reasonably long service (thousands of hours) and they can run at the low surface temperature of 60°C.

UV FOR FOOD TREATMENT

UV systems are widely used for water disinfection. Worldwide, the brewing industry is a huge user of UV water treatment as a non-chemical system. Other studies have demonstrated that UV light can be used to reduce levels of certain pathogens on pork skin and meat surfaces. There is an interest in and considerable promise of UV light to reduce levels of microbial contamination for a quite wide range of liquid foods and beverages. The example of the successful UV treatments is a combination with temperature process for orange juice. It was claimed by the authors that the level of vitamin C was not significantly reduced.

UV absorption effects of liquids are defined by the Beer-Lambert Law by incorporating an absorption coefficient. The presence of colored compounds in an aqueous medium, organic solutes or suspended matters lead to UV attenuation effects which are dependent on the concentration of the chemical species. For liquid food products, absorptivity can be relatively high; that means that the effective treatment requires alternative approaches to those normally employed for water. The two strategies are to perform the treatment: in the very thin liquid films or to increase turbulence in the device to bring all liquid elements into close proximity to the UV sources for a time sufficient to deliver the necessary UV-dose. The key to the successful treatment is to ensure that all surfaces receive sufficient irradiation to achieve the desired reduction in cell viability. Therefore, FDA is not specifying a minimum or
maximum dose by regulation, but concludes that this should be achieved for individual usage situations in a manner consistent with Good Manufacturing Practice (GMP). The expectations are that the maximum dose applied to the juice will be economically self-limiting due to the costs associated with UV irradiation.

UV-FOOD RESEARCH AT NCFST

A research project at the National Food Safety Center and Technology (NCFST), in partnership with FDA, Aquionics Inc, and California Day-Fresh Foods Inc. is currently investigating the efficacy of UV light to deliver 5-log cycle reduction of E. coli in apple cider. The team of NCSFT/IIT (Illinois Institute of Technology) Dr. Charles Sizer, Director, Dr. Tatiana Koutchina, Assistant Research Professor, and NCSFT/FDA scientists Dr. Edgar Murakammi, Dr. Lauren Jackson and Dr. Susan Keller will address the regulatory safety and quality aspects for commercial application of UV devices by small and medium sized producers.

After study of E. coli inactivation in the static UV reactor and absorptive properties of apple cider, field-testing was performed in a typical cider mill production setting in Placerville, CA in July 2000. The treatment of fresh apple cider in the thin film of the continuous-flow system showed the effectiveness of UV light to achieve regulatory requirements. In the coming year, two types of continuous-flow processings are planned to compare: very thin film treatment vs treatment in high turbulent flow. The UV unit donated to the Center by Aquionics Inc. will be used to test turbulent conditions of apple cider irradiation.

Another question that must be answered is the accurate estimation of UV dose delivered to the product. The dose calculations, based on the destruction of biological and chemical actinometers, will be compared with the measurements made by an ultraviolet sensor. The guidelines for commercial applications will be a deliverable from this project.

Finally, it should be noted that with the growing public reaction against chemicals in foods, the application of UV holds considerable promise as a purely physical treatment. FDA concluded the use if UV irradiation is safe. Moreover, UV irradiation has a positive consumer image.

Keith Carns, Oluf Hoyer and Karl Linden were elected International Vice Presidents. Uday Kelkar was elected International Treasurer. Jim Bolton was reappointed IWA’s Executive Director. Rip Rice was reappointed Editor of IUVA News.

A List of Attendees to the Congress was developed by Kathy Harvey -- available on IUVA’s Web Page (www.IUVA.org).

A proposal has been received from a group in Singapore to host a regional IUVA Conference in Singapore in August 2002. The Organizing Committee was empowered to proceed with evaluating and organizing this meeting. A decision will be made at the next Board meeting this Fall.

Proposals for the Second International Congress on Ultraviolet Technologies in Europe in 2003 will be coordinated by Regina Sommer and reported at the next IUVA Board meeting.

A Regional Workshop Committee was established to develop a series on UV technologies to be held in strategic geographic locations. Bruce Macler is Chairman of this new committee.

A Committee on UV Practice was established, to be chaired by Karl Linden. Proposed initiatives include development of specific “Technical Memoranda”, such as UV Technologies, Bench Scale Testing, Data on Microbial Effectiveness, How UV Fits in to UV Curing and Other Application Areas, etc.

A Who’s Who in IUVA will be developed by Jim Bolton and Kathy Harvey.

A Student Activities Committee was established to be co-chaired by Jim Malley and Susan Andrews. Some initiatives include student sessions at future conferences and Congresses, paper competitions, travel assistance for students, etc.

The feasibility of beginning a quarterly On-Line UV technical journal is being investigated – by Jim Malley.

The Board recommended that IUVA work closely with AWWA and WEF to develop a White Paper on Mercury Issues. Jen Clancy will coordinate this effort.

A Topical Group on UV Disinfection in Air is being formed. Those interested please contact Jim Bolton or Rip Rice (see insert on p. 3 for contact details).

The next Board meeting will be held in Atlanta, GA on Sunday morning 14 October 2001, just prior to the WEFTEC meeting. A parallel Board meeting will be held in Berlin, Germany following the IWA Conference (same week as WEFTEC).

Quite a list of accomplishments and significant beginnings.