Light Treatments

INTERVENTION SUMMARY	
Status	Currently Available
Location	Post evisceration, during chilling and post packaging
Intervention type	Surface exposure of carcasses, primals and products
Treatment time	10 seconds or prolonged
Regulations	UV treated water is used as a carcass rinse Approved for food contact surfaces and some brines and marinades
Effectiveness	Good where the product is exposed to the treatment Irregular shaped items may prevent uniform exposure
Likely Cost	Unable to Ascertain
Value for money	Likely to be Good
Plant or process changes	A 10-min treatment cabinet will take up a lot of space in a boning room, UV lamps can be retro-fitted within cold rooms and display cabinets
Environmental impact	Energy is required
OH&S	The unit would require proper shielding Exposure to UV light can cause skin cancer and damage the eyes
Advantages	Can be used on packaged product so no risk of recontamination
Disadvantages or Limitations	Can induce rancidity

Light Treatments

Ultraviolet (UV) light irradiation is commonly used in hospitals and laboratories for decontamination of surfaces, air and water. UV treatment has been used for a number of years in water purification and research is ongoing into the application of UV directly to foods. UV is an electromagnetic wave, lying outside the band of visible light. It has low penetrating power because it is a low energy wave, and its effectiveness is markedly affected by irregularities on the surface treated. Visible light can effect microbial destruction through the photo-dynamic effect, where toxins such as singlet oxygen ions are formed by light-absorbing molecules (photosensitisers). The intensity of visible light used for decontamination must be many times greater than the intensity of sunlight to have any practical benefit.

Ultraviolet Light

UV light causes permanent cross-links to form in the microbial DNA, preventing the cell from carrying out its normal functions (Sastry *et al.* 2000). The lethal effect of UV light varies with intensity and length of exposure, but temperature, pH, relative humidity and degree of initial contamination also affect its performance (Banwart 1989). UV light has low penetrating power, because its inherent energy is low in comparison with ionising radiation, so any obstruction to the path of the rays, such as dust, shadowing or clumping of bacteria can reduce efficacy. So the effectiveness of UV light is less on a rough surface than on a smooth one (Huang and Toledo 1982; Stermer *et al.* 1987). The effective wavelength is between 210 and 300nm (Banwart 1989). Sykes 1965 gave the ideal as between 240 and 280nm. Most commercial UV lamps deliver 90% of their radiation at 253.7nm.

UV light rapidly inactivates microorganisms in culture, killing up to 4 log before the death rate slows (Shapton and Shapton 1991). UV irradiation can sensitise bacteria to other food safety treatments such as heating or hydrogen peroxide treatment, and a synergistic effect may be obtained (Tyrell 1976; Bayliss and Waites 1980; 1982). Certain wavelengths produce ozone, which enhances the antibacterial effect (Kaess and Weidemann 1973), but excessive ozone can cause rancidity. UV treatments have also been associated with accelerated lipid oxidation and browning due to metmyoglobin formation, particularly in pork and poultry.

In general, anaerobic organisms are more sensitive to UV light than the aerobes, and Gram negative bacteria and rods are more sensitive than Gram positive and cocci (Sykes 1965), but successes have been reported against *Salmonella* on poultry (Wallner-Pendleton *et al.* 1994), and against *Pseudomonas aeruginosa* (Abshire and Dunton 1981). Most studies have used low intensity UV for 9 minutes or more, but if high intensity UV light was used, exposure times could be less than 10s (Stermer *et al.* 1987). Due to poor penetrative properties, UV light is more or less limited to surface applications, but it shows promise as a post-packaging treatment. Djenane *et al*. (2001) irradiated beef steak packaged in polyethylene pouches with modified atmosphere (70% O_2, 20% CO_2, and 10% N_2) and stored at 1°C and found that the shelf life was extended from 12 to 28 days. The UV was applied continuously at 1000 lux in a retail display cabinet. Under a standard fluorescent tube light, colour and odour deteriorated rapidly from day 6, whereas with the UV lamp, deterioration only became noticeable after dat 17, and was still scored as "slight" at day 28. Microbial counts from day 22 were 2 log lower in the UV-exposed packs than in the standard fluorescent light-exposed packs.

Coolroom UV units and UV water treatment systems can be obtained from Australian Ultra Violet Services Pty Ltd and Ultra Violet Products (Aust) Pty Ltd. From overseas, Safe Foods Corporation markets a UV system under the Fresh*Light* brand for use in liquids including brines and marinades, and Aquuionics or Hanovia supply air and water treatment systems.

Pulsed Light

Sunlight has been shown to reduce *Salmonella* enterica on stainless steel (Nyeleti et al. 2004), and to have a lethal effect on Bacillus spores (Abad-Lozano and Rodriguez-Valera 1984), but both these studies were carried out over a 12 to 24-hour exposure to sunlight, which would be somewhat impracticable for meats.

Pulsed visible light at wavelengths of 170-2600nm at energies of 0.01-50J/cm² in bursts of one millionth to one tenth of a second has been evaluated for treatment of beef and pork (Mertens and Knorr 1992). At these levels, the surface temperature of the meat rises rapidly and causes thermal inactivation. This treatment has been combined with an ultraviolet (UV) treatment to achieve greater microbial reductions. "PureBright" is a combined pulsed light/UV system reported to give reductions in total viable organisms of 1-3 log (Dunn *et al.* 1995). In this system, the energy was multiplied up using a capacitor, and it delivered several flashes of light per second, allowing fast throughput of product, and low energy usage. The intensity of pulsed white light is about 20,000 times the intensity of sunlight.

PureBright (PurePulse Technologies) is owned by Maxwell Laboratories: www.maxwell.com.

Unfortunately, at present, they have suspended operations due to financial reasons, and much research is still necessary to evaluate the application of pulsed light treatment in its application to meats.

Pulsed UV-light has been used to inactivate *E. coli* O157:H7 and *Listeria monocytogenes* on salmon fillets (Ozer and Demirci, 2006). About a 1 log reduction was achieved after a treatment time of 60s at 8 cm distance from the surface, with no detrimental effect to the product quality. The researchers used a laboratory-scale unit available from Xenon Corporation, distributed in Australia by Warsash Scientific Pty Ltd.

Issues to consider are possible discolouration of the meat due to high heat at the surface of the product, and OH&S.

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