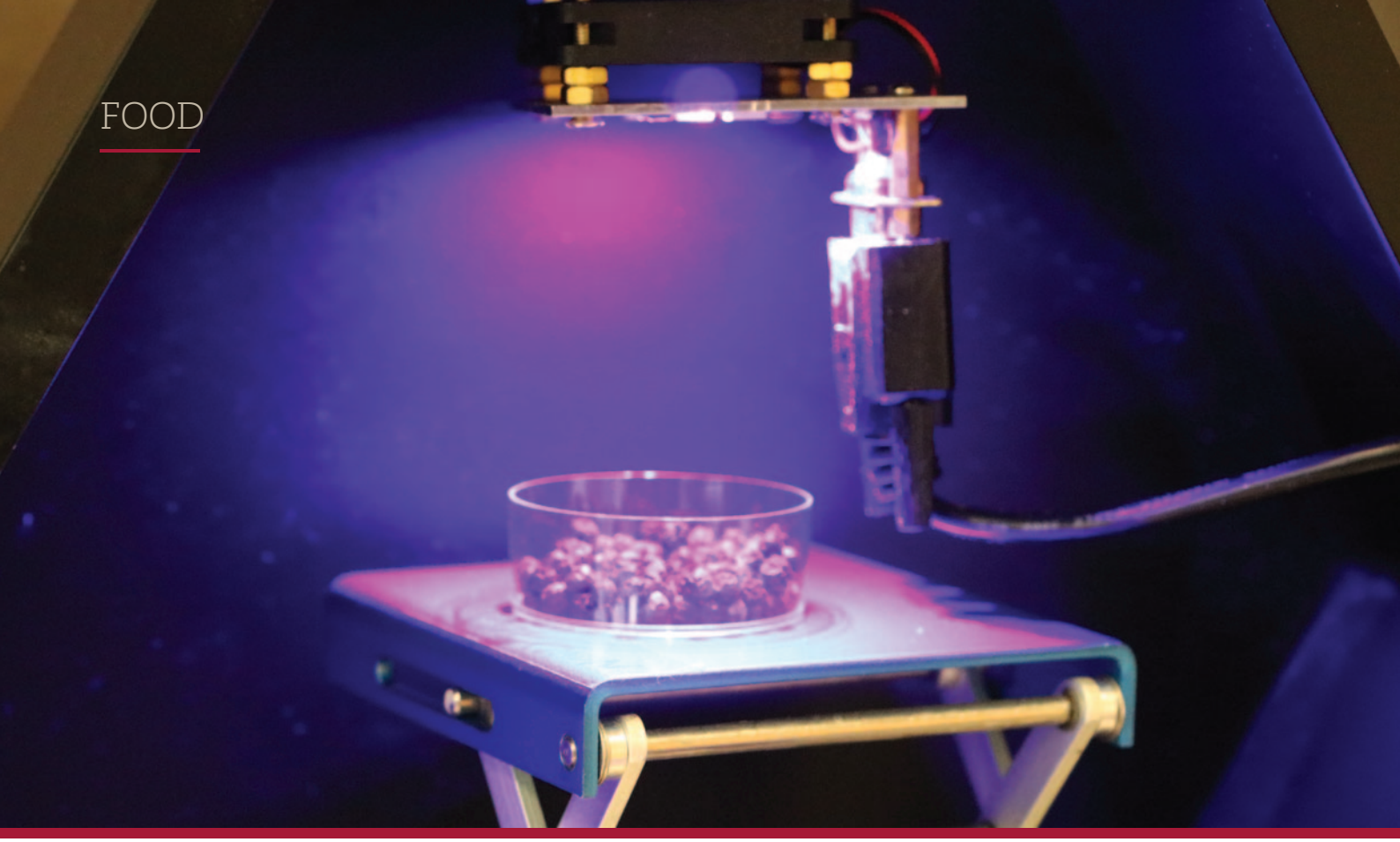

Food decontamination – seeing the light

TEAGASC researchers are investigating the potential of ultraviolet light-emitting diodes in food decontamination.

Ultraviolet light-emitting diodes (UV-LEDs) emit monochromatic light, which enables customised UV-LED disinfection systems at specific wavelengths to be developed. The application of UV-LEDs for disinfection purposes has been studied in recent years and now researchers are focusing on the application of this technology in the food industry. Recent studies have shown promising results that highlight the potential of this technology as a novel food decontamination tool.

LEDs are an alternative source of UV light, suitable for food industry applications that are safer, more environmentally friendly, and are becoming increasingly economical.

UV light technology has been investigated extensively, and has been used at commercial level across many fields, from medical device sterilisation to water treatment. UV is electromagnetic radiation within the 10 to 400 nm range on the electromagnetic spectrum, between X-ray and visible wavelengths. UV light may be subdivided and characterised based on wavelength and application. Three wavelength subdivisions are widely used in the scientific literature, namely UVA (315-400 nm), UVB (280-315 nm) and UVC (<280 nm). It should be noted that these classifications vary throughout the literature. UVC, which is known as the germicidal wavelength as it is highly effective, can damage the DNA of microorganisms because maximum DNA absorption occurs in the same range. UVA radiation mainly inactivates microorganisms by causing oxidative disturbance to the other biomolecules within the microorganism (Hinds, O'Donnell *et al.*, 2019).

Potential in the food industry

UV radiation has great potential in the food industry as a decontamination tool due to its many benefits and applications. However, traditional sources of UV, such as mercury lamps, are unsustainable and inefficient. LEDs are an alternative source of UV

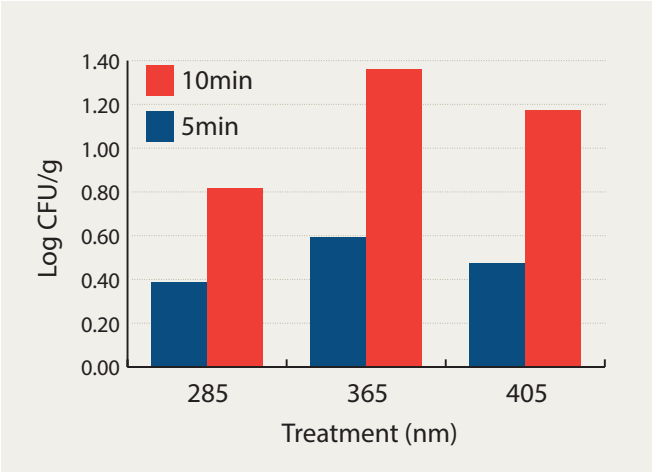

FIGURE 1: The effect of various UV treatments (285, 365, 405 nm) on the bacterial load in black pepper.

light, suitable for food industry applications that are safer, more environmentally friendly, and are becoming increasingly economical due to advancements in the semiconductor industry. As this is a novel approach, there are a limited number of studies that have investigated the potential of UV-LED systems for inactivation of food pathogens on solid foods. Foods investigated include meat products, dairy products, and fruits and vegetables. Significant reductions of microbial load (> 99 %) were achieved in studies, with quality parameters remaining unaffected. While these results are promising, further studies investigating the inactivation capabilities of LEDs on solid foods should be carried out to determine suitable treatments and investigate the possible effects of UV-LEDs on food quality.

These results show that this technology can be effective in inactivating food spoilage microorganisms in solid foods and therefore has potential as a food decontamination tool in the food industry.

The application of UV light for liquid food non-thermal pasteurisation has been widely studied. However, the applications of UV-LED for safety purposes are, again, limited. Teagasc researchers have recently published a study investigating the effect of various UV-LED treatments on food spoilage bacteria (*B. subtilis*) in different food mediums and reported reductions of over 99.9 % and 99.9999 % in model 1 (nutrient broth) and model 2 (peptone buffered saline), respectively. In addition, post-treatment monitoring was carried out for a duration of 18 hours (Hinds *et al.*, 2019). Further research was carried out for solid dried food ingredients. Black pepper samples inoculated with *B. subtilis* were subjected to various UV treatments and reductions of > 90 % were achieved (**Figure 1**). These results show that this technology can be effective in inactivating food spoilage microorganisms in solid foods and therefore has potential as a food decontamination tool in the food industry.

Advantages of UV-LEDs

UV-LEDs offer multiple practical benefits over commercial UV sources, such as zero toxic waste generation, longer life span, compact and robust design, no warm-up time and lower heat emissions. More significantly, UV-LEDs are commercially available at multiple wavelengths and therefore offer the capability to design customised UV reactors. However, while the semiconductor industry is making tremendous advances, there are still some issues with low efficiencies at lower UV wavelengths, which will need to be addressed.

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