

Instrumental Detection of Areas Requiring Spot Treatment

Spot treatment of carcasses, is commonly associated with traditional trimming of visible contamination or with steam vacuuming. Not all contamination is visible, however, and many pathogens and spoilage microorganisms may remain on a visually clean carcass. Thus there is a move to use methods other than human sight to detect the spots to which the treatment is to be applied. Some of these detection methods are outlined below.

Detection of contamination

Visual

Traditionally, carcasses are inspected, and offending areas of contamination trimmed by hand. This is effective for areas of visual contamination, and some bile staining, but can be hampered by poor lighting at the inspection point or a fast-moving chain where there is little time allowed for the QC inspection and trim (It also helps if the operative is not colour blind!).

Chlorophyll detection

The natural constituents of green plants, chlorophyll *a*, chlorophyll *b*, and protoporphyrin IX, absorb electromagnetic radiation of wavelength 400-475 nm, and this energy causes them to emit electromagnetic radiation, or *fluoresce*, at a wavelength of 630-700 nm. Meats, similarly, absorb and emit electromagnetic radiation, but in different wavelength bands – excitation occurs optimally at 360 nm, and emission at 420-520 nm. When 420 nm radiation is applied to meat, meat fluorescence is suppressed but the plant constituents will fluoresce (Kim *et al.*, 2003).

The technology (e.g., Verif-EYE system) allows the detection of contamination that is not visible to the naked eye, and is truly objective – if there is no plant matter, there will be no fluorescence in the detectable band. It can be used on carcass meat and on other surfaces, and gives an immediate result, so corrective action can be taken in real-time. Because it is detecting green plant matter, it depends on the animals being fed a chlorophyll-based diet, and there has been little success in its use on animals such as pigs and poultry. Where ruminants are purely grain-fed, and the diet contains little chlorophyll, the technology is less reliable than where the animals are grass-fed. Lee *et al.* (2013) tested the addition of chlorophyll rich feed ingredients to the diets of ruminants. They found that the addition of concentrated alfalfa extract improved the faecal fluorescence in cattle fed a concentrate diet. It did not however improve the faecal fluorescence of silage fed cattle. False-positives may occur where light is reflected from the surface at the critical wavelength for detection, for example on excessively wet carcasses. Bone and some connective tissues may also reflect the light. Some vegetable-based marking inks have also been noted to fluoresce, as they too contain the green plant constituents. The technology is available as a carcass cabinet, or as a hand-held unit,

with the latter being easy to use with only a little practice, but it is affected by ambient light levels – if the surroundings are too brightly lit, the fluorescence is harder to detect.

Preliminary work in the UK has shown that although there is no direct correlation between fluorescence and bacterial contamination, there is a good relationship between the extent of the fluorescence and the probability of having high microbial counts on the carcass (Reid *et al.*, 2005).

The Verif-EYE system developed by eMerge was sold to the Chad Company in the US in 2007.

Spectroscopy

Spectroscopy works on the basis that the chemical bonds within an organic molecule will absorb or emit light when they change from one energy level to another, in response to excitation by light at a particular wavelength, or heat. The emitted light can be detected in a similar fashion to that outlined above for chlorophyll detection. Considerable work has been done over the past few years on the use of spectroscopy in the meat industry, primarily for assessing meat quality and spoilage (Ellis and Goodacre, 2001, Elmasry *et al.*, 2012), but it also has the potential to be used for detection of bacterial contamination on meat, as bacterial cells will produce a different emission wave from the meat itself (van Kempen, 2001). There are a variety of different spectroscopic techniques that have been investigated, including infrared (IR) and Raman spectroscopy. Spectroscopy has the potential to identify specific pathogens on meat by detecting the spectral fingerprint of the pathogen. Meisel *et al.* (2014) used Raman microspectroscopy to correctly identify pathogens inoculated onto beef and poultry. This technology is not yet commercially available, but trials are underway in a number of research centres worldwide.

Bacterial ATP detection

All living cells are powered by energy units of adenosine triphosphate (ATP), and this energy unit can be used to drive a bioluminescence reaction that occurs naturally in fireflies. The more ATP there is, the more power, so the brighter the luminescence, just as in a bicycle dynamo powering a lamp. This technique has been used to detect residual organic material on surfaces after cleaning, as it detects the presence of living cells. The kits available are very easy to use, giving a result in the form of a luminosity figure in minutes, the greater the figure, the more cells there are on the swabbed surface. Total ATP measurement, however, does not distinguish between bacterial cells and mammalian cells, so is not useful for carcass testing.

New, sophisticated ATP systems have been developed where the carcass can be sponged, and the sponge treated with a chemical to remove the body cells, so that the ATP detected is of bacterial origin only. These systems give results in 5 minutes, and can detect levels as low as 2 - 3 log cfu/cm² on carcasses (Siragusa *et al.*, 1995). Further research is in progress to produce systems that will detect specific organisms, allowing processors to target particular pathogens of concern.

ATP detection is currently probably of more use as a hygiene monitoring tool than for targeting contamination on an individual carcass.

www.biothema.com; www.berthold.com.au

Detection of microbial phosphatase

Phosphatase is an enzyme that occurs naturally in most raw foods and in microorganisms. Testing for this enzyme is commonly used in the dairy industry to assess the efficacy of pasteurisation. The phosphatase produced by microorganisms is more resistant to heat than mammalian phosphatase. A sample taken from a carcass surface is heated to 75°C for 7 minutes, to remove the meat phosphatase. The microbial phosphatase can then be detected using a simple chemical reaction, the products of which can be measured by colour analysis or fluorescence techniques, giving a numerical result in approximately 10 minutes. The greater this number, the more microorganisms present on the sample.

This test is also of more use as a hygiene monitoring tool than for targeting contamination on an individual carcass, although a kit aimed at carcass monitoring gave a good correlation with carcass microbial count (Kang and Siragusa, 2002).

www.cytoskeleton.com (Note: Most of these are very technical kits, and can be more targeted at commercial laboratories rather than for use in the field.)

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