Why and how to monitor hygiene and cleaning

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Preventing food poisoning is a key focus of any food safety system. Food poisoning is usually caused by the proliferation of undesirable micro-organisms, and cross-contamination and inadequate sanitation are major contributory factors.

Accordingly, Good Hygienic Practices are primary preventative control measures. Hygiene monitoring provides an early warning of potential problems and also generates evidence of due diligence. Optimising cleaning programs also reduces costs (both in materials and labour time), reduces environmental waste and improves product quality and shelf life.

Prevention is key

Prevention is a key element of the Food Safety Act since 1990 that incorporates the principles of Hazard Analysis Critical Control Point (HACCP), but non-compliances still happen in high profile cases, for example E. coli O157 outbreaks in Scotland and Wales in the past 10 years. The cost of failure is high both in terms of human suffering and monetary value.

The Food Standards Agency (FSA) estimated that around one million people suffered from a foodborne illness leading to 20,000 hospital admissions and 500 attributable deaths at a cost of £1.5 billion. The FSA has calculated that every 1% reduction in the incidence of foodborne disease extrapolates to 10,000 fewer cases each year with a saving of £15 million.

Table 1 shows some statistics from 2008 and a dramatic rise in the incidence of campylobacter, particularly in raw chicken, and also the high mortality rate associated with a relatively small number of cases from Listeria monocytogenes. A key element in most cases is cross contamination from raw foods.

The FSA strategy for 2010-2015 includes the development and implementation of risk management programs to reduce the incidence of these pathogen bacteria in the food chain, in addition to better surveillance and enforcement.

Table 1. Foodborne illness statistics 2008 for the whole of the UK.

Organism	No. of cases	No. of deaths	Deaths (%)	Main cause/source
Salmonella	26,962	77	0.3	Raw meat/poultry/ cross contamination
L. monocytogenes	358	126	35.2	Chilled ready to eat foods
E. coli O157	1054	23	2.2	Raw meat/ cross contamination
Campylobacter	321,179	76	0.0	Raw meat/poultry/ cross contamination
Cl. perfringens	52,530	55	0.1	Prepared and ready to eat foods
Norovirus	201,279	32	0.0	Shellfish

Food hygiene delivery

The Food Hygiene Delivery Programme (FHDP) was set up to drive forward actions to respond to the recommendations of the Public Inquiry into the outbreak of E. coli O157 in Wales in 2005 (published in March 2009).

The FHDP was established to prioritise, direct and measure progress in an ambitious and comprehensive programme of work to improve food hygiene delivery and enforcement across the UK, covering all foodborne pathogens and all food groups.

The FHDP has concentrated on making sure that the delivery of food hygiene official

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controls is properly undertaken. It aims to reduce the level of foodborne disease through:

- Improved awareness and control of food safety hazards by food businesses, food law enforcers and consumers.
- Reliable assurance that compliance with legal standards is maintained, using timely, effective and proportionate enforcement where necessary.

This comprehensive program will run until 2013 and will include initiatives such as:

- All food business operators being aware of the hazards from foodborne pathogens, and ensuring that their food management systems and procedures are capable of preventing cross-contamination – the output of 100% compliance with the requirement to have food safety management systems (or clear and demonstrable progress towards it).
- Ensuring that food safety management practices are embedded in every food business, and are helped by us and by local authorities to achieve this through advice, education and training as well as formal enforcement action – the output of all food businesses having a food safety management system that stands up to validation and verification by local authority/MHS.
- FSA to issue better guidance on solutions to be used to prevent cross-contamination from surfaces and equipment – the issuing of such guidance.
- A more forensic approach to inspection, with decisions about confidence in management being based on evidence and subject to verification.
- Better audits by FSA, to include a means of assessing how food hygiene inspections are undertaken by local authorities, including their validation and verification of food safety management plans.

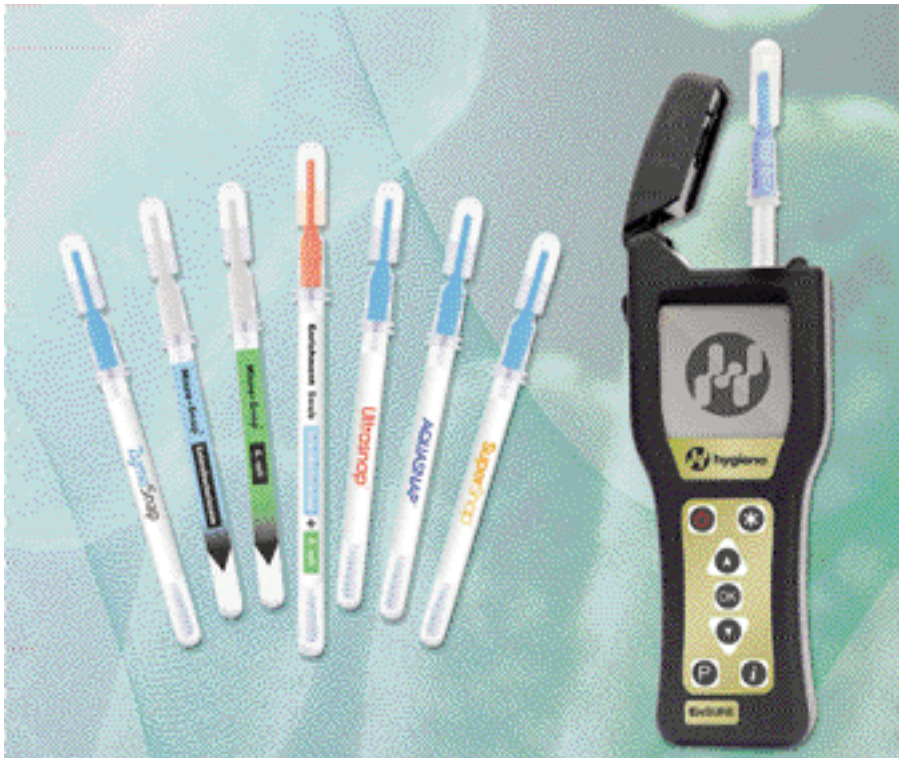
Demonstrate due diligence

Accordingly, high standards of hygiene are essential for food safety and so cleaning and maintenance are critical control points and there is an increasing requirement to demonstrate due diligence by monitoring to validate and verify cleaning processes.

Insufficient regard is given to the technology and practice of cleaning and sanitation, and a simple bucket chemistry approach usually leads to ineffective and wasteful process. The choice and application of detergents and sanitisers is a science in itself, where optimum conditions for chemical dosing and contact time and temperatures are critical. Detergents are designed to remove organic matter of the product residue from surfaces as a primary process prior to adding a sanitiser to disinfect the cleaned surface.

The effective removal of product residue is of prime importance since it not only removes gross contamination (organic matter and 90% of the micro-organisms) but removes any product residue that could support the subsequent survival and growth of microbes.

Accordingly, the effective removal of product residue is more important than residual micro-organisms. But how can the efficacy of cleaning processes be assessed?



Traditional monitoring

Until the 1980s the only method available to measure the hygienic status of food contact surfaces was the conventional cultural method based on agar plate counts. These methods provide information about the number of microbes present on the surface and also have the advantage of being able to detect specific indicator organisms.

However, these methods tell us nothing about product residue left on the surface that can support the survival and growth of microbes.

Microbiological tests need to be conducted in a laboratory by a skilled technician. These traditional tests have been packaged into more convenient, user-friendly formats that save time and labour in the small or busy laboratory. However, the results are generally available in 24-72 hours, which is too slow to provide useful feedback information to the sanitation and manufacturing processes and ensure that high standards of food safety and quality are maintained.

The ideal test

The primary objective of cleaning is to remove product debris, so the ideal test to measure the efficacy of cleaning and hygienic status is a test for product residue itself.

This should give rapid results to facilitate immediate corrective action, and be simple enough to be performed on the production floor by the sanitation crew or supervisor without the need for a laboratory.

The philosophy of considering 'soil' rather than just micro-organisms to assess cleanliness is not new and Griffiths (1997) states that 'freedom from organic soil is thus a better indication of cleanliness'.

There are several alternative methods for measuring the hygienic status of product contact surfaces that approach the ideals above. There are instrumental methods and simple visible colour tests.

ATP bioluminescence

In the 1980s the detection of ATP by a bioluminescence assay was applied to the detection of contaminants in foods and hygiene monitoring. This biochemical test uses an enzyme luciferase that emits light in the presence of ATP.

The light is measured quantitatively in an instrument called a luminometer and results are available in 15 seconds. Since almost all organic matter contains ATP (the universal energy carrier), it is present in almost all foodstuffs in huge amounts. ATP is also present in viable microbes (albeit in tiny amounts).

Therefore, most of the ATP detected on product contact surfaces is derived from food residues. Microbes present on cleaned surfaces (typically <500 cfu/100cm^2) are too low to be detected directly by their ATP content only.

Many reports over the past 20 years have shown a good correlation between surface

cleanliness and plate counts, such that it is now a widely accepted method of hygiene monitoring.

The first luminometers were large bench top instruments designed for laboratory use, and the test reagents were provided as freeze dried powder in bottles or vials of 25-50 test.

These first reagents had a short working life when rehydrated, usually 1-2 days at refrigerated temperatures. This meant that the test needed to be done by a skilled analyst, reagents were wasteful and hence the test was not cheap.

Smaller, portable luminometers were then made that could fit into a briefcase and were easily carried, however they generally required two hands to operate and so the instruments were used on a bench or desktop but away from the laboratory close to the production area.

Sophisticated software

In 2003 a truly portable palm-sized instrument was developed that also dramatically reduced the capital cost of the instrument without compromising performance of the test.

Advances in miniaturisation and computerisation enables small instruments to have a large data storage capacity for sample and user identification and to analyse results.

Simple but sophisticated software enables results to be downloaded for further data manipulation, record keeping, trend analysis and due diligence.

Reagents for ATP bioluminescence and their packaging have also been improved to provide single-shot, all-in-one test systems that offer convenience and ease of use.

However, the majority of these use the same freeze-dried reagent technology and reproducibility can be compromised in single-shot devices. A novel liquid-stable luciferase has been developed that has none of the drawbacks.

The ATP test is very sensitive and will detect very small amounts of product residue, typically <1ppm depending on the foodstuff. Food enforcement officers are now using the test to demonstrate (quickly and simply) the importance of correct cleaning practices and identify hot spots that present a risk (see Table 2).

New bioluminogenic test

ATP bioluminescence has exquisite sensitivity, gives results in seconds and has widespread application as a post-cleaning verification test. However, the ATP test itself cannot differentiate between different sources of ATP unless considerable time and effort is used to remove or chemically reduce non-microbial ATP in order to detect microbial ATP.

A new 'bioluminogenic' test has been developed by Hygiena International that uses the speed and sensitivity of ATP bioluminescence but coupled to the utilisation of specific substrates.

Enzymes capable of digesting these specific substrates then drive the established light generating mechanism. The test is robust because the sample itself does not interfere with the reaction mechanism.

The bioluminogenic test called Micro-Snap is capable of detecting specific bacteria such as coliform and E. coli, and detecting low numbers (1-5) in seven hours.

Other indicator and pathogenic bacteria such as Listeria monocytogenes can also be detected.

Similarly, enzymes of industrial importance such as acid phosphatase can also be detected by the bioluminogenic test called Zymo-Snap.

This gives results in two minutes and can detect raw meat residues on a solid surface or can be used to check if meat has been cooked and not subsequently cross contaminated with raw meat.

A new improved instrument (called EnSURE) with increased sensitivity is used with Micro-Snap and Zymo-Snap. In addition, a reagent swab device called Supersnap also gives more sensitivity and robustness and can also be used with EnSURE to give a super-sensitive hygiene monitoring applications particularly in support of allergen control programs.

Table 2. Use of ATP bioluminescence test to monitor and verify cleaning efficiency.

Area tested	Initial reading	Re-clean	Re-clean
Pie prep laminate worktop	961	191	29 OK
Pie prep stainless steel drainer	306	32 OK	
Vac pack machine nylon packer	318	26 OK	
Vac pack machine – inside base	97		
Berkel slicer – blade area	501		
Last slice guard	70		
Carriage	129	92	
Cooked meat scales – stainless steel	730	2 OK	
Shop prep area – laminate	592	44 OK	

Colour hygiene test

ProClean is a simple colour test that detects protein and amino acids, hence it is applicable for meat and fish processors. It gives a change in colour from green to purple in 1-10 minutes depending on the contamination level. The reaction is visible to the naked eye, so no instrumentation is required to run the test which is less sensitive than ATP bioluminescence.

Accordingly, protein tests can provide a simple, semi-quantitative hygiene test to verify cleaning and hygiene.

These tests are appropriate for butchers, small food processors, retail and catering outlets, food service/restaurant applications and auditors/inspectors.

Other colour hygiene tests used for cleaning verification include SpotCheck Plus. It detect simple sugars present in food residues and gives results in 60 seconds. The speed and intensity of the colour change from colourless to green is indicative of the level of contamination. This test is more suitable to catering applications because it detects a broader range of foodstuffs.

Summary

Effective cleaning and hygiene are essential pre-requisites for food safety management. Food business operators are required to demonstrate compliance and provide evidence of due diligence. There is an acceptance that rapid hygiene monitoring methods that detect food residues on product contact surfaces provides a direct, objective, relevant measurement of cleaning efficiency and hygiene.

The developments in technology and convenience packaging provide a variety of technologies and products that are user-friendly, affordable and applicable to almost all food processors, caterers and inspectors.

The ATP hygiene test is the simplest, fastest, most sensitive technique for rapid hygiene monitoring. It correlates well with contamination levels and is widely accepted.

The latest development in this technology now provide an instant test to detect raw meat contamination, and other tests detect specific bacteria giving results in the same working day.

Rapid hygiene tests provide additional information in a timely manor to supplement food safety programs by facilitating immediate corrective action and the avoidance of expensive (potentially life threatening) mistakes. Results provide evidence of due diligence, optimising manufacturing processes and reducing costs, whilst providing a product quality dividend. ■

References are available from the author on request.