Cleaning and hygiene: the front line defence for food safety

by Martin Easter, Hygiena International Ltd, Unit 11 Wenta Business Centre, Colne Way, Watford, Hertfordshire, UK.

Preventing food poisoning is a key focus of any food safety system. Food poisoning is usually caused by the proliferation of undesirable micro-organisms. Cross-contamination and inadequate sanitation are major contributory factors. Accordingly, Good Hygienic Practices are primary preventative control measures that are part of the essential Operational Pre-Requisites Programmes of modern food safety systems (see Fig.1).

Hygiene monitoring provides an early warning of potential problems and also generates evidence of due diligence. Optimising cleaning programmes reduces costs (both in materials and labour time), reduces environmental waste and improves product quality and shelf life.

Prevention is a key element of the Food Safety Act (1990) that incorporates the principles of Hazard Analysis Critical Control Point (HACCP) but non-compliances still happen, for example in high profile cases of E. coli 0157 in Scotland and Wales in the past 10 years. The cost of failure is high, both in terms of human suffering and monetary value.

Organism	No. cases	No. deaths	Deaths (%)	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 0157	1054	23	2.2	Raw meat/poultry/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

Table 1. Foodborne illness statistics 2008.

The UK 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, including a dramatic rise in the incidence of campylobacter particularly in raw chicken, and 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 programmes to reduce the incidence of these pathogen bacteria in the food chain in addition to better surveillance and enforcement.

The Food Hygiene Delivery Programme (FDHP) 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 FDHP 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. It has concentrated on making sure that in the delivery of food official controls are 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 programme includes initiatives such that all food business operators are aware of the hazards from foodborne pathogens, and ensuring that their food management systems and procedures are capable of preventing cross-contamination – i.e. the output of 100% compliance with the requirement to have food safety management systems embedded in every food business that stands up to validation and verification by local authority/Meat Hygiene Service.

FSA will conduct better audits and a more forensic approach to inspection with decisions about confidence in management being based on evidence and subject to verification.

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.

Table 2 shows the results from a survey of a wide variety of caterers and establishments:

- Surfaces claimed to be clean by food business operators (FBOs), and which were visually clean, contained very high levels of contamination.
- 70% of caterers exceeded the ATP limits , and only 30% showed good levels of cleanliness.
- For many test locations from both product and hand contact sur-

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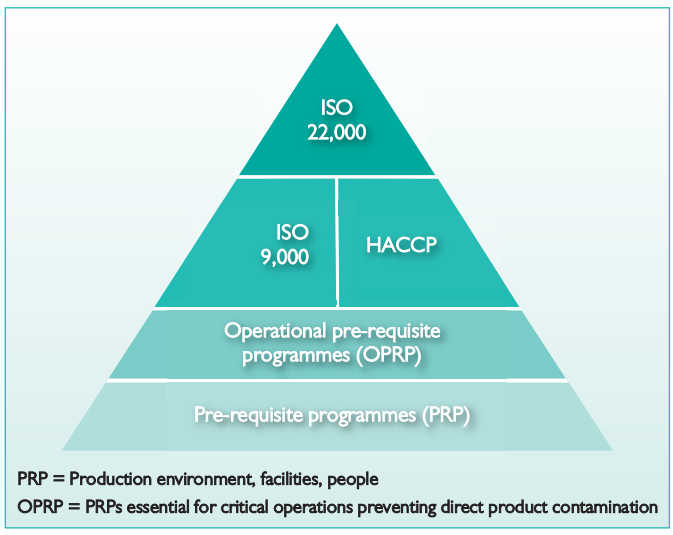
Fig. 1. Food safety pyramid diagram.



PRP = Production environment, facilities, people
OPRP = PRPs essential for critical operations preventing direct product contamination

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faces, the average scores were 10-20 times higher than the expected target levels.

- Many individual results were more than 160 times greater than the expected target level.
- Inadequate cleaning procedures were frequently identified as the cause.
- FBOs were shocked and galvanised into corrective action by the demonstration of their failings and being shown efficient cleaning procedures.
- Chopping boards were very difficult to clean effectively because the porous nature and heavy scoring retains the invisible contamination.

Insufficient regard is frequently given to the technology and practice of cleaning and sanitation, and a simple bucket chemistry approach usually leads to ineffective and wasteful processes. 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.

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 (Armbuster, 1962) and Griffiths (1997) states that 'freedom from organic soil is thus a better indication of cleanliness'.

There are several test methods available to measure hygiene and cleanliness. ATP bioluminescence has been used for over 30 years and is a well established accepted method that is used by industry, retailers and local authorities, and is recommended by BRC.

The technology requires a small hand held instrument and an all-in-one reagent swab device. There are also simple colour tests (for example ProClean) that detects protein and amino acids, hence it is applicable for meat and fish processors. A colour change from green to purple is observed 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.

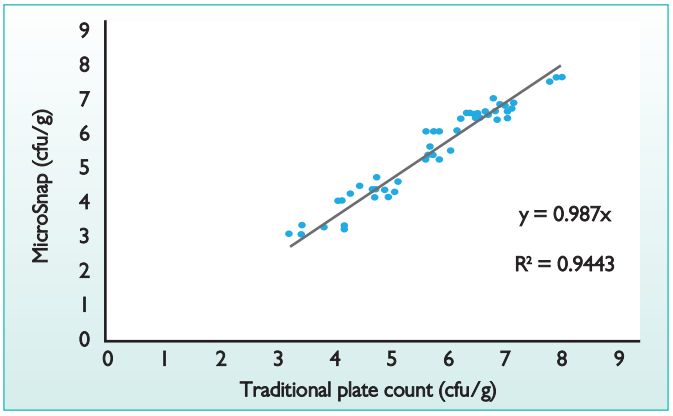

Fig. 2. Correlation of MicroSnap Total with traditional plate counting method.

Traditional cultural microbiological methods provide results in 24-72 hours, which is too slow to provide useful feedback information to the sanitation and manufacturing processes and require laboratory conditions and a skilled analyst.

However, a novel development of the ATP bioluminescence technology has enabled it to specifically detect and measure bacteria to give results in the same working day or shift of seven hours. MicroSnap Total can detect and enumerate over a large dynamic range. Good correlations of >90% are obtained for a wide variety of foods including meat products (Fig. 2).

More importantly, MicroSnap can also be used to detect at a fixed specification, thus reducing the detection time still further to 1-3 hours (Table 3).

Table 3. MicroSnap detection time for raw meat.

Number of bacteria	Detection Time (hours)
10^1 (10)	7
10^2 (100)	5
10^3 (1000)	3
10^4 (10,000)	1
10^5 (100,000)	1
10^6 (1,000,000)	1

Table 2. Cleanliness survey of food preparation surfaces in food outlets.

Sample location	Target (RLU)	Average (RLU)	Maximum (RLU)	Good cleaning		Poor cleaning	
				Before	After	Before	After
Chopping boards	50	609	4274	2798	5	2186	4132
Food contact surfaces	50	499	3866	3866	29	821	375
Food preparation surface	50	987	6760	6473	33	983	324
Packaging equipment	50	647	6310	482	35	6310	?
Slicing equipment	50	1110	8103	4759	38	8103	1177
Utensils	50	273	2723	2732	15	752	232
Fridge handle	100	808	6717	6717	10	482	1017
Hands	200	566	5786	1492	92	3613	1660
Taps	100	1534	8258	8258	38	8194	3745
Cleaning cloths	200	1118	7451	1225	42	7451	2331

This new 'bioluminogenic' 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. MicroSnap can be made specific for indicator bacteria such as coliforms and E. coli and pathogens such as listeria.

Similarly, other substrates can be used to detect specific raw meat residues such as acid phosphatase in the CrossCheck test that will detect the presence of raw meat residues in <5 minutes. The test can be used to verify thermal processing and measure cross contamination hazards on product and hand contact surfaces in segregated areas of meat production facilities.

A new improved instrument (EnSURE) with increased sensitivity is used with Micro-Snap, Cross-Check and other specific tests. In addition, a reagent swab device called SuperSnap also gives more sensitivity and robustness and can be used with EnSURE to give a super-sensitive hygiene monitoring application particularly in support of allergen control programmes.

Summary

Effective cleaning and hygiene are essential pre-requisites for food safety management but are frequently not implemented to a satisfactory standard. 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 developments 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 manner to supplement food safety programmes 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. ■