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Hygiene Monitoring in support of Food Safety

- a review of methods and industry trends

Background

Good Hygienic Practices are an essential to ensure food safety. They are required by law under national and international Food Hygiene Regulations and are frequently considered as pre-requisites to food safety systems based on Hazard Analysis such as HACCP.

Preventing food poisoning is a key focus of any food safety system. Food poisoning is usually caused by the proliferation of undesirable micro organism for which some of the most common causes include inadequate segregation of raw materials and finished product, inadequate temperature control during processing and / or storage, cross-contamination and inadequate sanitation. Accordingly Good Hygienic Practices are a primary preventative measure and the monitoring of their effectiveness not only provides and early warning of potential problems but also evidence of due diligence. Optimising cleaning programs also reduces costs (both in materials and labour time), reduces environmental waste and has a product quality dividend by improving shelf life. An optimised system frequently provides savings of 20 – 50% in chemical usage.

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 the 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 then efficacy of cleaning processes be assessed? In this article we will review the available methods for hygiene assessment and monitoring.

Traditional Hygiene Monitoring

Until the 1980's 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 e.g. ready-poured plates, dehydrated plates, dipslides, all-in-one swabs and dilution devices, identification test strips etc. However the results are generally available in 24 – 72 hours, which is too slow to provide usual 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.

Alternative methods and technologies.

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 1980's the detection of ATP by a bioluminescence assay was applied to the detection microbes in foods and hygiene monitoring. Pioneered initially by Lumac, 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 20 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 much smaller amounts). 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 by industry, retailer and regulatory agencies.

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 shelf life when rehydrated for use usually 1 – 2 days at best at refrigerated temperatures which mean that the test needed to done by a skilled analyst and was not cheap. Smaller, portable luminometers were then made that could fit into a brief case and were easily carried, however they generally required two hands to operate and so the instruments were used on a bench or desk-top but away from the laboratory close to the production area. Computerisation brought with it the ability to program additional sample identification data into the instrument and download data for further data manipulation, record keeping and trend analysis. There are several commercially systems for measuring ATP bioluminescence and hygiene applications and the current trend is to add other features to the instrument to extend its application either to other ATP based assays, or other tests such as pH and temperature. The next development in instrumentation is be the truly portable palm-sized instrument where the challenge is to reduce the capital cost of the instrument without compromising performance of the test.

Reagents for ATP bioluminescence and their packaging have also been improved to provide single-shot, all-in-one tests 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 drawback. The *snap*shot device is stable for 12 months at refrigerated temperatures and is very robust being tolerant to temperature abuse at 25^{o}C for 6 – 8 weeks with out loss of significant loss of activity or performance. More importantly snapshot has a coefficient of variation of 25 - 30% that is three times better than other devices such that reliability and consistency are guaranteed, and *snap*shot fits most luminometers.

Colour hygiene test

Several different technologies can be harnessed to provide a simple colour test for food residue that are visible to the naked eye, do not require an instrument and give results in 1 - 10 minutes. Accordingly these tests are appropriate for small and large food processors but also catering outlets and food service applications.

These tests are generally less sensitive than ATP bioluminescence but provide a simple, semi-quantitative hygiene test. These biochemical tests can detect ATP, or NADPH (another energy-carrying molecule present in organic matter and living organisms), or protein, or simple sugars. Some produce a single colour change while others produced multiple colour change depending on the level of contamination. There a single-shot, all-in-one test formats and reagent kits in bottle format.

The two most common commercially available colour hygiene tests are those detecting protein or simple sugars. Protein tests generally detect protein and amino acids only and are applicable to foodstuffs that are high in protein such as meats, whereas sugar tests detect a much broader range for foodstuff (see table). There are several different commercial protein test kits that operate on different detection technologies and some require a total test time of 1 minute while others require 10 minutes to demonstrate the absence of contamination and verify cleaning has been conducted properly. ProTec detects protein and the colour changes from green to purple in 1 – 10 minutes depending on the contamination level. SpotCheck and SpotCheck*Plus* detect simple sugars and changes from colourless to green where the speed and intensity of the colour change over a 60 second period are indicative of the level of contamination.

Summary

There is an acceptance that hygiene monitoring methods that detect food residues on product contact surfaces provides a direct and relevant measurement of cleaning efficiency and hygiene. These methods do not necessarily replace the traditional cultural methods but provide an additional information in a timely manor to supplement food safety programs by facilitating immediate corrective action, providing evidence of due diligence, optimising manufacturing processes and reducing costs whilst providing a product quality dividend.

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 and caterers.