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Microbiological product testing

To test or not to test?

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About the author

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Professor Griffith has a BSc and PhD in Microbiology. He has worked in the USA, Sweden, the UK and South Africa and has lectured on aspects of food microbiology and food safety for over 35 years in over 20 countries.

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With apologies to Shakespeare, the question in the subtitle is very relevant to all food businesses, including those in South Africa. The microbiological testing of food products is an expensive process but can be justified if it results in safer food. Most manufacturers only think of the costs associated with implementing the testing and fail to think of costs it may save e.g. those associated with failing to produce safe food, which are becoming increasingly expensive. High punitive food poisoning settlements, long associated with the USA, are also seen in other countries (Anonymous, 2012). So an important question to answer is, "Can microbiological testing help to produce safe food? If so, when and how should testing be undertaken and how should the results be used?"

The history of microbiological product testing goes back almost to the birth of food microbiology (Griffith, 2006) but historically was used to help decide if a consignment or batch of food should be accepted or rejected with microbiological end product testing (MT) fitting into a food safety equation (**Equation 1**) linking good manufacturing practice (GMP) and food safety inspections (classically of the floors, walls and ceiling approach and distinct from modern food safety audits).

Equation 1 - Historical Approach to Food Safety Management

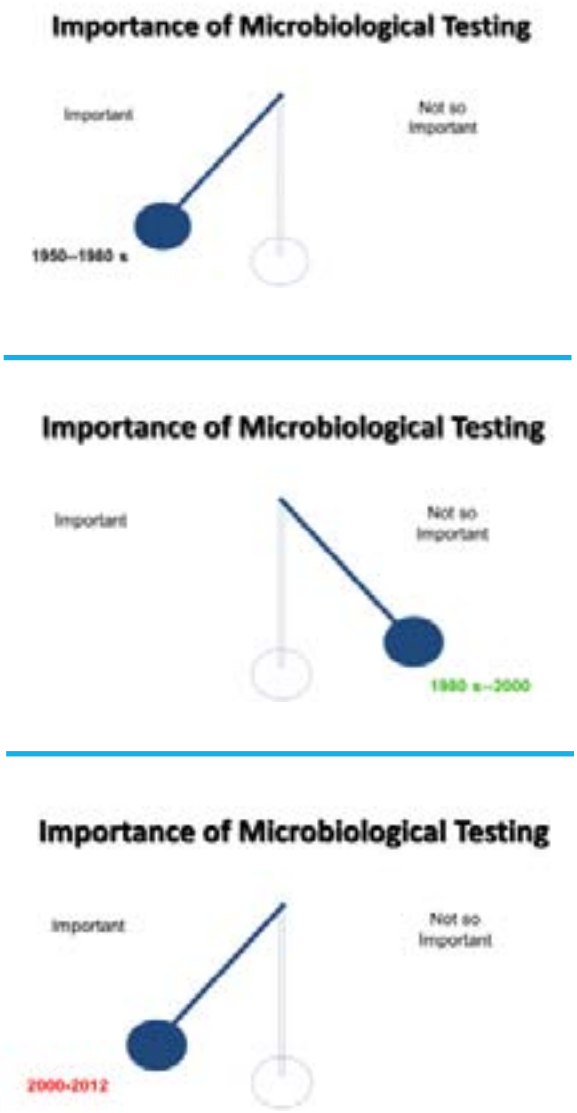
MT + GMP + Inspection = Safe Food (SF)

The use of this approach to guarantee safe food is flawed. Microbiological testing is considered reactive i.e. does not "ensure" food safety (ICMSF, 2002 ; CFA, 2007) and tells you largely whether something went wrong. Other disadvantages include problems with sampling, time taken to obtain results and heterogeneous microbial distributions in food (**Table 1**).

Table 1:

Problems with microbiological testing as a means of managing risks
• Process is reactive and retrospective – something went wrong
• Variation in sampling methods
• Variation in microbiological methods
• Speed of results
• Control lies in the laboratory
• Limited number of samples
• Statistics of sampling and sample selection
• Ability to detect and cultivate specific organisms
• Variability – microorganisms not "normally" distributed – multiple samples

Figure 1



With the advent of Hazard Analysis Critical Control Point (HACCP) the value of end-product testing was questioned (**Figure 1**) and there was a school of thought that, especially as the results can take anything from one to eight days which is often too late for corrective actions to be taken, it had relatively little value in a modern approach to food safety management. HACCP is a proactive, preventative approach to risk management and works in conjunction with relevant prerequisite programmes (PRPs) (Griffith & Redmond, 2009) (**Equation 2**).

Equation 2 - Used As The Basis of Food Safety Management Between Approximately 1990s -2005

PRPs + HACCP = SF

However, in reality, microbiological testing is still a very important component of producing safe food but what has changed is the thinking on where, when and how such testing should be performed (**Table 2**)(ICMSF, 2002) and how the results should be used. Sampling should not be based on "grab sampling" but used as part of a structured approach, with the benefits most useful in informing you about the efficacy of your food-safety management systems especially if combined with trend analysis.

Table 2:

Reasons for microbiological product testing
• Validate control measures • Verify HACCP/food safety management systems/food quality management systems • Assess variation between batches • Assess supplier performance/ingredient suitability • Show compliance with criteria • Guidance on food quality with no historical data • Understanding your processes/processing • Problem solving • Shelf life testing and assessment • RISK ASSESSMENT

This type of information assists manufacturers in identifying if/when corrective actions or systems review are necessary and should be one of the first things requested/ examined by external auditors. This type of approach is required within HACCP, with Codex logic sequence step 11 (CAC, 2003) requiring the introduction of verification procedures. Thus, the use of microbiological testing integrates with the use of PRPs and HACCP.

Vital though this is, it would be wrong to think this was the only use of microbiological product testing. The last decade has seen increased recognition of the importance and merits of "in process" testing , especially with the use of risk assessment (RA) as part of food safety management (see equation 3) (ICMSF 2002) . "In process" testing can be used to set performance objectives throughout production, distribution and retailing, and to monitor the achievement of performance criteria at various critical stages as well as analysing exposure routes/pathways of product contamination. The latter is especially important given the increasingly recognised role of cross/post process contamination in causing outbreaks of food poisoning (Griffith and Redmond, 2009) and emphasises the need for producers to undertake a structured programme of environmental and food contact surface testing. Collectively these help to provide an integrated approach to food safety management (**Figure 2**) with microbiological testing informing the other three components. Ideas on the correct timing of sampling (a result is only as good as the quality of the sample that was taken) in addition to surface testing (which tells you what is likely to get into the product (Griffith, 2005), coupled with the correct application and trending of the results have, therefore, changed.

Equation 3 Used As The Basis of Food Safety Management Between Approximately 2005 -2010

PRPs + HACCP + RA+ MT =SF

However, other things are also changing in the world of food microbiology. Historical disadvantages of microbiological testing have included the time and effort taken to get results and the last 10 to15 years, in particular, have seen the development of rapid and automated test methods. These apply to both quantitative (enumeration, how many organisms) and qualitative (identification of organisms) approaches to microbiological testing and fall into two basic categories.

Firstly, existing traditional methods can be made easier/simpler or more rapid. For example, the use of petrifilm (quantitative) does away with the need for petri dishes, and a lot of technician time and can be counted automatically in a petrifilm reader. However, the philosophical principles are still the same as a traditional plate count. Similarly, identification systems such as the API system are based upon "traditional" biochemical approaches which have been simplified and automated.

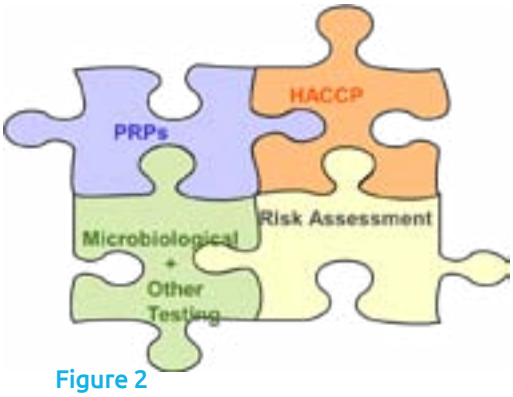


Figure 2
Producing safe food: management systems

Completely novel approaches to quantify microbial product contamination include the use of impedence, ATP and flow cytometry, and their use is increasing in South Africa. Results will not be presented as the familiar cfu/g but as total bacterial activity (TBA) or an equivalent. Novel qualitative approaches for identifying organisms include various types of immunoassay (e.g. ELISA or latex agglutination), as well as molecular methods such as Pulsed Field Gel Electrophoresis (PFGE) and ribotyping. These very specific approaches to microbial identification have proved exceptionally useful not only to government agencies in food poisoning outbreak investigations, but also to manufacturers wishing to identify sources of contamination and/or track the presence of specific organisms in their food products or plants.

The continued value of using microbiological testing is well recognised around the world in legislation. For example, the EU Regulations on the Microbiological Criteria for Foodstuffs (2005) require the use of trend analysis and surface testing with the results linked to corrective actions required by the producer. Equivalent regulations, especially as part of a risk-based approach, are lacking in South Africa. Nevertheless, the principles that have been outlined reflect the thinking of the ICMSF and can be very useful to food producers.

So, to answer the question " to test or not to test ", the reply is most certainly yes but in a way which provides maximum benefit for the costs incurred and can save money in the longer term. Microbiological testing should be structured, using rapid techniques where possible and should be one component of an integrated approach. The results should be used in trend analysis and should inform the producer of the efficacy of the other components (PRPs and HACCP) of their food safety management systems. Used in this way, microbiological testing provides value for money and will continue to be an important part of food safety management.

The last few years have seen the emergence of a modified Equation 3 with the inclusion not only of microbial testing and risk assessment (RA), but with the addition of a food safety culture (FSC) component (**Equation 4**). Beyond the scope of this article this increasingly important topic is a measure of a company's collective commitment and attitudes (not an individual's) to food safety and manifests itself in the degree of compliance with the systems (Griffith 2010, Griffith 2014). In the final analysis it is the output from all these that determines the microbial load (numbers and types of organisms) in the end product which will, in turn, be determined by correctly implemented end product testing.

Equation 4 - Used As The Basis of Food Safety Management 2010-TheForseable Future

PRPs + HACCP+ RA + MT + FSC = SF

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