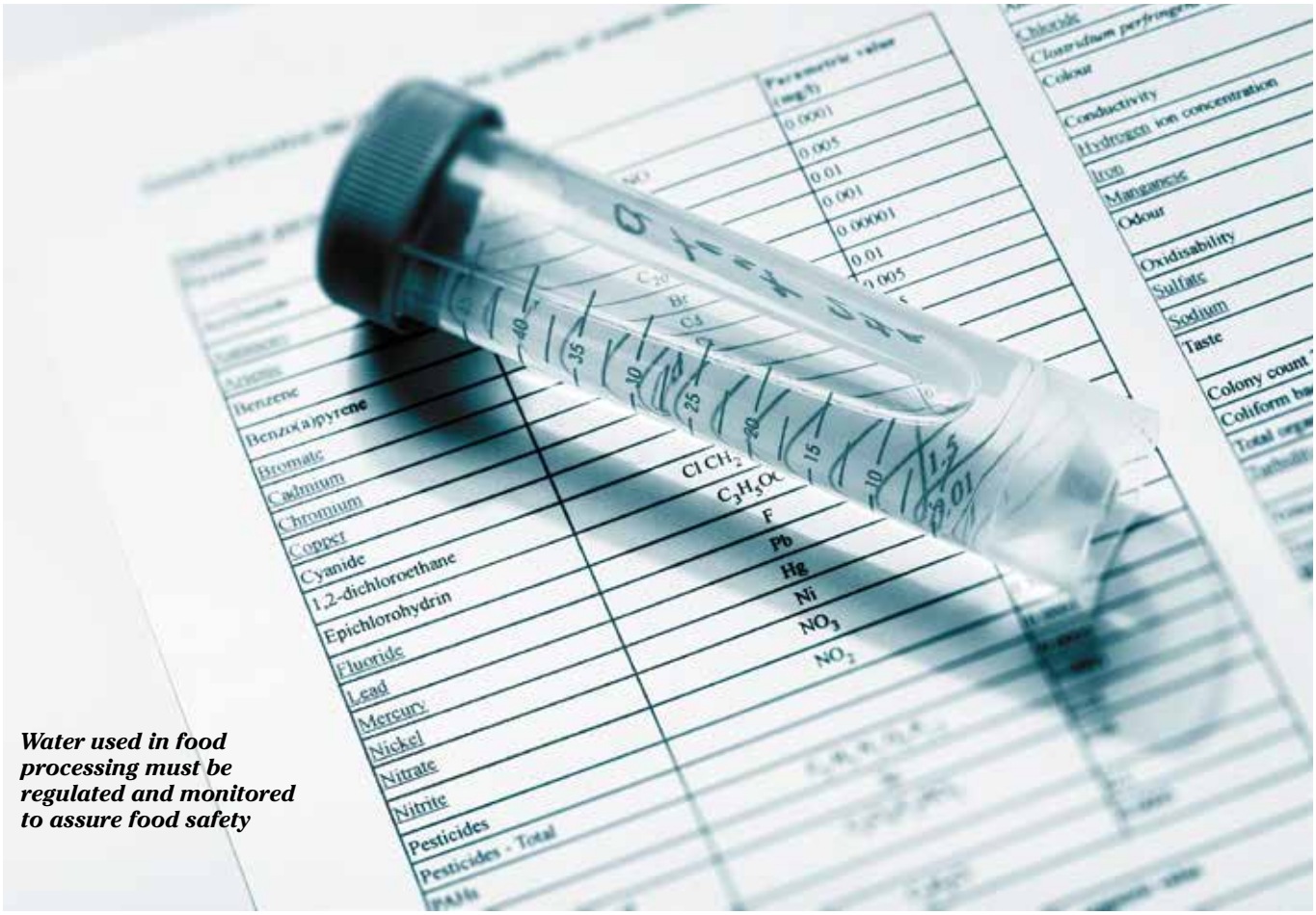

Water used in food processing must be regulated and monitored to assure food safety

Ensure the safety of your process water

FoodInc: Food Industry consulting group

Assuring water quality and safety in food processing

Introduction

Most of us take water for granted, thanks to improvements in public health over the past century.

As food producers and processors, we require good quality water for a range of operations, including washing, blending or mixing, cleaning, ice making, steam production and product transportation in-process. To assure food safety, we must operate within a framework based upon sound science that ensures water quality in process, and optimises its use.

As found in the recent water quality issue in Havelock North, drinking water provides an efficient route for the spread of pathogens. It is essential that food processors take steps to assure that water and food are completely safe and suitable.

Water as an ingredient poses the biggest challenge in terms of quality and purity. Not only must it be safe but also it must not impart off flavours, odours, colour or create product stability issues due to presence of transition metals. High levels of metallic and non-metallic compounds also pose a risk. High nitrate levels in drinking water may lead to methaemoglobinemia (blue baby syndrome) and have been implicated in an increased risk of stomach cancer (Chambers et al., 2001). Methaemoglobin (MetHb) is formed when nitrite (formed from the endogenous bacterial conversion of nitrate from drinking water) oxidizes the ferrous iron in haemoglobin (Hb) to the ferric form. Levels of nitrate in drinking water should not be greater than the WHO guideline value of 50 mg/L

The Ministry of Health, in its rationale behind the Health (Drinking Water) Amendment Act 2007 states New Zealand has relatively high rates of largely preventable enteric or gastro-intestinal disease in comparison with other countries[1]. This is at least partly attributable to contamination of drinking-water. The highest rates of cryptosporidiosis occur in areas where water is either ungraded or graded as unsatisfactory[2].

Good Manufacturing Practices and HACCP

The Food Act 2014, and the subsequent Food Regulations 2015, specify the requirements for process water and water as an ingredient and

Case Studies

Studies into over 60 waterborne outbreaks from 15 affluent nations have identified recurring themes and patterns (Hrudey and Hrudey, 2004[3]) including critical human dimensions such as risk management approaches, personnel training and regulatory control. The Hrudey and Hrudey paper discusses these outbreaks in great detail, with critical analysis of the reasons for the outbreaks.

The 2016 Havelock North waterborne disease outbreak saw an estimated 5530 people, with 1072 notified cases (Hawkes Bay District Health Board[4]) contracting Campylobacteriosis from the Council-supplied, bore-sourced drinking water. The final report into the source of the contamination will result from a wide ranging inquiry.

Further New Zealand cases[1]

- 3500 cases in Queenstown 1984
- 69 cases of viral gastroenteritis at a major ski field in 1996;
- 61 cases of Campylobacteriosis at a school camp near Christchurch in 1997;
- 67 cases of Campylobacteriosis at Wainui in 1997;
- 187 cases at a college in May 2001 – of which only two were originally reported to the Medical Officer of Health;
- 49 cases at a school camp in the Waikato in 2003.
- 5 reported cases of Cryptosporidiosis from the Masterton town water supply during July and August 2003
- 213 known cases of acute gastroenteritis due to norovirus (and probably many more unreported) at Cardrona ski field in July 2006).
- 1072 cases of Campylobacteriosis in Havelock North 2014

give guidance to the food industry (including retail and food service operations) on how to ensure its safety.

Under the Food Regulations 2015, water is classed as an essential service, essential to the production or processing and handling of food. Its definition is broad and includes ice, steam and seawater.

Section 21 of the Food Regulations 2015 requires operators to ensure that any water used for producing food, processing and handling food, personal hygiene, cleaning, or any other purpose is suitable for the purpose for which it is used; and does not adversely affect the safety or suitability of food. In addition to this, the capacity of the water supply to the place of food business must be adequate for the operations of the food business.

Water source

Drinking water is supplied to the food industry either publicly, by local government authorities, or privately by the food business itself. However, the water used to supply the drinking water can come from a variety of sources including surface water (e.g. streams, rivers, and lakes), groundwater (e.g. natural springs, wells, bores), rainwater and seawater (treated at a desalination plant).

Regulation of water quality

As a significant ingredient in many food products and associated with many processes that occur within the food processing industry, water must be regulated and monitored to ensure that it does not result in food for sale being unsafe to eat.

Management of drinking-water in New Zealand is covered by four Acts and associated regulations and standards.

- The Resource Management Act 1991 covers the source of the water, either from below ground or from surface catchments.
- The Health Act 1956 covers procurement and supply of raw water from the environment, followed by storage, assessment, treatment, and distribution to the consumer.
- The Health (Drinking Water) Amendment Act 2007 was a milestone in New Zealand as all water suppliers had for the first time a duty to ensure their water was safe to drink.
- The Health Act is supplemented by the Drinking Water Standards for New Zealand 2005 (DWSNZ, revised 2008) which specifies maximum acceptable values of harmful microbial, organic, inorganic, and aesthetic contaminants in water E.g. *E. coli* (less than 1 per 100ml), total pathogenic protozoa (less than 1 per 100ml). The associated Guidelines for Drinking-Water Quality Management for New Zealand provides additional advice on monitoring and treatment to meet the DWSNZ.

Timeframes for compliance with the Health (Drinking Water) Amendment Act 2007 are based on water supplier category i.e. neighbourhood, agricultural, small, minor, medium, and large population groups and are dependent on the size of supply. All water suppliers serving more than 500 people are required to take all practicable steps to comply with the DWSNZ (previously voluntary) and to develop and implement a Water Safety Plan by 2016 (essentially enables Council's to opt out of Drinking Water Amendment Act 2007 by detailing how and when they will implement the standards) Because of this, the majority of water suppliers, outside of the main centres do not currently meet the DWSNZ.

The Building Act 2004 governs the storage and distribution of water in tanks and pipes within buildings up to the point of use. This Act takes over responsibility for water once it leaves a public networked supply and enters the building-owner's property (water meter), and applies to water distributed within a building from its private self-supply (e.g., a roof tank or bore). The Protection of groundwater sources from a well or bore is assured by following NZS 4411:2001 Drilling Standard.

It is the source of water which generally determines the quality of the water and whether treatment of the water is necessary to ensure it meets drinking water standards and is safe to be used in food production (i.e. safe for human consumption).

The provision and treatment of private water supplies used by the food industry is the responsibility of the specific food business using the supply. Typically, private water supplies will require treatment and ongoing verification following treatment (e.g. laboratory testing) to ensure they are fit for human consumption and can be used in food production

To assist many businesses, the "Template" Food Control Plan, published by the Ministry for Primary Industries has expanded the regulations to give more guidance on the use of water within the food industry. The main area of focus of food control plans is the prevention or minimisation of contamination of food. Essential to this is the availability of suitable water, which includes water as an ingredient, as a processing aid and as hot and cold water for cleaning and hand washing.

In New Zealand, we are fortunate that systems are in place, through local councils (registered suppliers), to treat and provide safe, potable water to residential and commercial customers in their region. This makes the task of ensuring safe and suitable water consumed within the food industry much simpler. Although testing of water supply within food factories for absence of *E. coli* is common (and necessary to ensure the council supplied water has not been contaminated on site), the presence of a low level of residual chlorine is very effective in maintaining pathogen free water supplies.

Where water is obtained from other sources, such as surface, ground water or roof water, businesses will need to comply with the self-supplied water requirements set out in Part 2 of MPI's Food Notice: Food Control Plans and National Programmes (15 December 2015) to operate a Food Control Plan. Refer Table 1.

Table 1: Testing requirements for self-supply water (DWSNZ)[1,2]

Test	Criteria
E. coli	Less than 1 in any 100ml sample
Turbidity	Must not exceed 5 Nephelometric Turbidity Units (NTU)
Chlorine (when chlorinated)	Not less than 0.2 mg/l (ppm) free available chlorine with a minimum of 20 minutes contact time
pH (when chlorinated)	6.5-8.0

Guidance.

Operators of Food Control Plans are responsible for the safety of supplied water from the point at which it enters the business. This includes keeping water pipes in sound condition, flushing after repairs and maintenance and flushing to remove stagnant water if not used for more than seven days. Any water tanks must be kept clean and in good repair to prevent build-up of sediment and be covered and have screened openings to protect against access by animals, birds and debris.

Any self-supplied water must also be safe to use with food and meet the requirements for clean water. Where water supply comes from a roof collection area, it must only come from roofs and gutters made from safe substances (e.g. no lead-based paint, bitumen, exposed timber or copper guttering). Precautions such as screening guttering and removing overhanging vegetation should be done to reduce contamination potential. Also, a first flush device must be installed and used to divert the first flush of water when it rains.

A water treatment system may be necessary to ensure that self-supplied water is safe for use. Typical water treatment systems include a combination of filtration, chlorination, UV disinfection and others. Any system must be installed and maintained in accordance with the manufacturer's instructions and be regularly checked for effective performance. This may include testing for free chlorine at levels of at least 0.2mg/L (recommended weekly testing) or regularly testing for the absence of *E. coli* (at least every 3 months). Guidance should be sought from equipment suppliers or your local public health unit water assessor.

Compliance with the above requirements will give any food processor confidence that any water used within their process is not a contamination source for their products. But, as with any system, its performance needs to be monitored to ensure on-going compliance.

Treatments and techniques

Most processors draw water from city water supplies or wells. The standard food manufacturing plant assumption is that these are safe sources but this needs to be verified.

Water treatment processes remove pathogens and impurities that may otherwise be harmful to human health or aesthetically unpleasant. Treatment processes vary depending on the source water. But typically, an adsorbent material is added to the water to bind dirt and form heavy particles that settle to the bottom of a water storage tank. The water is then filtered to remove even smaller particles. Finally, a small amount of disinfectant (e.g. chlorine), at a level safe for human consumption, may be added to kill any remaining microorganisms.

The use of chlorine depends very much on pH control. The optimum pH is 7.4. Above 7.8 chlorine is ineffective. Whilst the free chlorine content can be high, very little chlorine occurs as active hypochlorous acid, but rather as inactive hypochlorite Newer sanitising agents are less pH dependent, including chlorine dioxide and Anolyte (hypochlorous acid) from electrolyzed water.

Examples of specific applications

Recombining milk powders

In general, good clean safe city water with no objectionable flavours, odours or high levels of suspended solids must be the starting point for recombining or reconstituting dairy powders.

The 'salt' balance is most important for physical stability when UHT treating or sterilising high protein dairy products as it affects heat stability, viscosity and shelf life.

The mineral content (calcium and magnesium) needs to be limited

with total hardness at a maximum of 100mg/litre as $CaCO_3$, which is lower than the general domestic water supply.

Where fat is present in the product there should be no traces of copper (no brass fittings) or iron which easily trigger fat oxidation. When processing oils the water should be softened to remove calcium, magnesium and iron salts.

Chloride, sulphate and nitrate levels are also recommended to be lower than general domestic water.

Nitrate levels are particularly relevant for all water used for infant formulas and foods: these should not exceed 45mg/l as NO_3. This is particularly important where water is drawn from supplies affected by dairy runoff.

Canned food processors

Canned food manufacturers are required to have >5ppm free chlorine in their post-process cooling waters to prevent microbiological post-process contamination of the contents as the rigid container seams contract while cooling.

Leafy salads wash water.

Chlorination and monitoring of wash waters is essential to ensure the maintenance of free chlorine levels. pH must be monitored regularly as this affects free chlorine levels. Similarly with make-up water.

See pg 21 for more.

Analytical methods and kits

Your laboratory can undertake some basic tests such as pH and turbidity using test kits. Pathogens, metals and pesticides testing needs to be conducted by qualified analytical laboratories.

It is common practice to test process water, at least annually, for the presence of *E. coli* to ensure that no contamination has occurred in the reticulation system.

Water suppliers publish test results on a regular basis. These reports should be obtained by food processors as part of their monitoring programme:

- Annual and monthly reports can be downloaded from some water suppliers' websites. These reports include tests conducted on water leaving the local supply plant and within the distribution network.
- Ministry of Health (MoH) annual compliance survey is reported publicly in July each year.
- The MoH Annual Microbiological and Chemical Quality of Drinking-Water Supplies, is available on their website and is issued in Nov/Dec each year, covering the previous year for all water suppliers, water treatment and network results. (MoH, 2015[7])
- Water Information NZ (WINZ, http://www.drinkingwater.esr.cri.nz) is a public source of information and for those managing water quality.
- Regional Council websites also detail the location of all bores in their areas.

Conclusion

The rules governing food safety include requirements for adequate supplies of safe drinking water for use in food production[1,2]. As such the safety of water supplies directly affects the safety of food. Therefore, food businesses should follow good-sense practices when considering the source, treatment and intended use of water in food production to ensure the quality and safety of the foods produced. All food companies should know the composition of their process and ingredient water and test it regularly.

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