

treatment and cross-contamination controls in the milk powder manufacturing process must be strictly followed. Similarly to cocoa beans, raw nuts may become contaminated with *Salmonella*; in 2009 a major recall in the United States linked to peanut butter demonstrated the impact of such issues on the industry (Carr, 2010). As with cocoa beans, the roasting step and preventing post-process contamination are essential controls. The presence of *Salmonella* has also been linked to other common confectionery raw materials, including egg products, flours and starches, lecithin and coconut (Cordier, 1994).

Although *Salmonella* is the main organism of concern for chocolate manufacturers, it is also important that all raw materials are assessed during HACCP studies for other microbiological hazards – for example freeze-dried fruits used as inclusions in chocolate products could be at risk of contamination by viruses or other enteric pathogens.

Careful supplier selection and auditing is important to ensure that incoming ingredients will be microbiologically safe for use in the chocolate making process, particularly because the microbiological safety of the chocolate products relies entirely on the use of safe ingredients and the control of cross contamination during processing and packing. Regular risk-based microbiological monitoring of incoming raw materials should be carried out. Ingredients should be inspected on arrival to ensure they are in good condition, with no damage or signs of pest activity.

25.6.3 Prevention of microbiological contamination during processing

In addition to the incoming cocoa beans and other raw materials, it is important to consider the other possible sources of microbiological contamination, including *Salmonella*, in the chocolate process.

Once again, good manufacturing practices are imperative in the prevention of *Salmonella*. All employees, visitors and contractors should strictly follow basic personal hygiene rules. These must include thorough hand washing and drying, removal of jewellery, prevention of hand to mouth contact (e.g. prohibition of eating in the production room), provision of appropriate work wear, pre-employment medical screening of food handlers who may be carriers of micro-organisms capable of causing food-borne diseases and reporting of cases of sickness and diarrhoea by workers, with exclusion from food handling duties until clearance is given.

Pest management is important to prevent potential pathogen-carrying pests such as birds, insects and rodents from entering the food production area. This includes ensuring that buildings are pest proofed with no unscreened windows or gaps below doors, keeping the interior and exterior of the premises tidy and clear of waste and spillages that will attract pests, and employing an effective pest control system of baits and traps for early detection.

Rework must be hygienically collected, carefully stored in clean, dry, covered containers or closed bags and kept in suitable storage areas. Its condition should be assessed before use to ensure there has been no possibility of contamination.

Waste must also be hygienically collected and stored in covered containers or bags designated for waste use only, and its disposal must be controlled to prevent cross-contamination from external to internal areas.

Movements of people and vehicles between production and non-production areas must be minimised to prevent cross-contamination from external areas.

25.6.4 Water control and cleaning practices

A key element in the prevention of *Salmonella* in chocolate processes is the minimisation and control of water.

Cleaning procedures used in chocolate manufacturing and processing are normally focussed towards dry cleaning wherever possible. Dry cleaning procedures include manual scraping, brushing and vacuum cleaning. Use of water should be minimised but, where it is absolutely necessary, equipment must be designed for this purpose, with surfaces that can be easily and quickly dried and visual inspection possible after cleaning. Cleaning tools should be dedicated for food contact surfaces – normally through a clear colour coding system – to ensure that equipment used to clean the floor does not come into contact with that used to clean the production line.

Linked to this, hygienic design of equipment is an important factor – ensuring that the “cleanability” of processing equipment is considered during its design, minimising complex surfaces, avoiding hollow bodies, allowing full access for people and tools during cleaning and easy dismantling and reassembling of the equipment where necessary. Walls and floors should be well constructed, smooth and impervious and capable of being easily cleaned. Storage tanks and hoppers should be covered and plant layout should be carefully assessed, ensuring that pipes, cables or other installations that may collect dirt, leak, cause condensation or otherwise contaminate the product are not located above uncovered product flow. Condensates from cold water pipes, refrigerator coils and cooling tunnels can introduce water into an otherwise dry environment. Cool surfaces in warm areas should be insulated and the temperature of coolers should be correctly set for the throughput of the production line and thereby minimise risk of condensation (IOCCC, 1993). Hygienic design of the process must also be revisited in the event of any changes to the process, product or environment.

Water leaks are also a potential source of contamination. Much of the equipment used during chocolate processing is kept warm by water jacket systems, for example to maintain pipeline temperatures, tempering zones and storage tank jacket temperatures. This can lead to the risk of corrosion and micro leaks, especially in older installations. The water circulates through the system, often