SANITATION OF LIQUID EGG PRODUCTS BY NONTHERMAL PROCESSES: HACCP AND INACTIVATION STUDIES

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Foodborne disease outbreaks involving *Escherichia coli* O157:H7 and *Salmonella enteriditis* in liquid egg products (LEPs) are the major public health concern. Egg is a principal source of the *S. enteritidis* able to colonize the ovarian tissue and is present within the contents of intact shell eggs. Most of the *S. enteritidis* outbreaks have been associated with shell eggs or egg containing products. Although statutory action has been taken at breeding flock level, contaminated eggs and LEPs remain the main source of infection. The special facility of *S. enteritidis* to cause prolonged infection of the avian reproductive tract has been a major factor in vertical transmission of the organism from breeding flocks and internal contamination of eggs is thought to have been the major factor in its spread *S. enteritidis* localizes in glandular parts of the reproductive tract. The level of shell contamination usually correlates with visible faecal contamination of shells and with the degree of excretion of *Salmonella* in faeces but *S. enteritidis* originating from the oviduct can be found on shells even when no *Salmonella* is present in faeces. *Salmonella* on egg shell shows a rapid natural reduction in ambient conditions but survival may be prolonged in more humid or cold conditions and some strains of *S. enteritidis* show more prolonged survival than others. Contaminated shell may also cause cross contamination in the kitchen or fragments may become included in bulked LEPs. Vaccination has a beneficial effect on egg contamination but there is still some contamination risk associated with the presence of *S. enteritidis* in infected vaccinated flocks. Rapid cooling by forced air, especially after washing, which increases the heat retention of stored eggs, can be used to reduce the opportunity for bacterial multiplication but lower temperatures can enhance survival of *Salmonella* on shells. Food safety programmes focus increasingly on the farm-to-table approach as an effective means of reducing hazards. This holistic approach to the control of food-related risks involves the consideration of every step in the chain, from raw material to food consumption. Hazards can enter the food chain on the farm and

can continue to be introduced at any point in the chain until the food reaches the consumer. In order to eliminate *Salmonella*, the primary control must be at farm level.

As a result, these products must be processed in sanitary facilities under continuous inspection and pasteurized before distributed for consumption. In the production of ready to use and shelf stable liquid egg products (LEP); pasteurization is the fundamental process to eliminate pathogenic microbes from the product. The most common pasteurization method for LEP is the thermal treatment (for the egg yolk 60°C/6.2 min, egg white 55.6°C/6.2 min, whole egg 60°C/3.5 min). Thermal pasteurization is the most available and best understood technique, however, it may affect the physical (coagulation, foaming and emulsifying) and functional properties (technological and nutritional) and decrease the quality of LEPs.

Alternative pasteurization methods including UV-C radiation, ultrasonic wave treatment, high electric field pulses, high hydrostatic pressure or ultrapasteurization combined with aseptic packaging have been explored to extend the shelf life and minimize disadvantages of thermal processing of LEPs. In spite of the fact that some of these methods have limitations, nonthermal food processes can be a food safety tool that serves as a complement to other food safety technologies such as HACCP. The dose required for each individual application should be established by risk analysis, taking into consideration the contamination level, the hazard involved, nonthermal process parameters, and environmental factors such as oxygen presence, the efficiency of the nonthermal treatment as well as the fate of critical organisms during manufacturing and storage.