

A Hazard and Exposure Assessment of Enterococci in Whole Milk Powder and Skim Milk Powder

Giménez, M.L.¹, Heuer, C.¹, Cogger, N.¹, and Tebje-Kelly, J.¹

¹Massey University, Palmerston North, New Zealand

Abstract

Enterococci (EN) are present in the environment, the gastrointestinal tract of animals and humans, and raw milk. Some strains of EN are used to improve sensory attributes of cheese, protect against food spoilers, or as probiotics. Other strains of EN possess virulence factors and antibiotic resistance traits that could represent a hazard for human health. In New Zealand, EN are not used for dairy processing but are primarily regarded as contaminants during primary production. The objectives of this study were to evaluate enterococcal survival in whole milk powder (WMP) and skim milk powder (SMP) through the processing chain. The process chain began at milk collection and concluded with packing and storing. Throughout this chain there were several intermediate steps, many of which involved exposure to high temperatures. The pathway provides a framework to evaluate the likelihood that EN are present in WMP and SMP. It showed a number of key heating stages that should effectively inactivate enterococcal bacterium. We hypothesize that the commercial heating steps, including High Temperature Short Time (HTST) pasteurization at 72°C for 15 seconds, would be sufficient to reduce EN to undetectable levels. We intend to investigate this further by using this pathway to qualitatively estimate the likelihood that a consumer will be exposed to EN as a result of consuming WMP and SMP products.

Introduction

For many years, EN were considered harmless commensals with low pathogenic potential for humans. This view is changing because the role of EN in nosocomial infections appears to be increasing. The problem is greatest in patients with preceding antibiotic therapies or long and severe underlying diseases (Franz et al. 1999, 2003; Giraffa 2002, 2003; Kayser 2003; Murray 1990). It has been suggested that the pathogenicity of EN is due to the presence of virulence traits in some strains (Franz et al. 1999, 2003; Mannu et al. 2003). It seems however, that only some strains of EN (mainly of clinical origin) have these virulence traits (Franz et al. 2003).

Exposure to EN may be the result of consumption of dairy products as EN are normal components of the raw milk microbiota. A study of the levels of EN in raw cow's milk from 10 New Zealand farms in 1997, found that EN counts ranged from $<10^1$ CFU/ml to 1.2×10^4 CFU/ml, although 95% of the samples of the same study had less than 1.9×10^3 CFU/ml (Hill and Smythe 1997).

While EN are accepted as naturally occur in raw milk and whey, and consequently in their raw or semi-cooked sub-products, high cell counts are indicative of a poor level of pasteurization or unsatisfactory hygiene practices during the collection or processing of milk (Cogan et al. 1997). If EN are present in sufficient numbers they can behave as spoilage micro-organisms and cross-contaminants during food processing.

There is a need to determine if the EN present in the raw milk are present in the final dairy products. This paper describes a pathway that could be used to estimate the likelihood that the organism will be present in WMP or SMP at the end of the processing.

Methods

The manufacture of WMP or SMP is essentially the same, differing only in that the raw material is either whole or skim milk, respectively. Figure 1 describes the normal pathway for the production of WMP and SMP. Briefly, the process involves initial pasteurization of the raw milk at HTST followed by a pre-heating stage. Depending on whether low-heat or high-heat powder is being manufactured, the pre-heating ranges from 80 °C/1 second – 120 °C/several minutes. The next step involves evaporation stage, where temperatures drop from 70 °C to 40 °C as the liquid passes through each evaporator effect. After evaporation, the concentrate is heated at 70-80 °C/several seconds, after which it is dried. The primary drying stage (in a drying chamber) provides the highest air heating temperatures, 150-250 °C, followed by secondary drying (in a fluid bed) and then cooling (in a second fluid bed). The powder (2.8% moisture) is then sifted, filled in containers, packed, sealed, coded, weight-checked, palletized, stretch-wrapped, and stored prior to export.

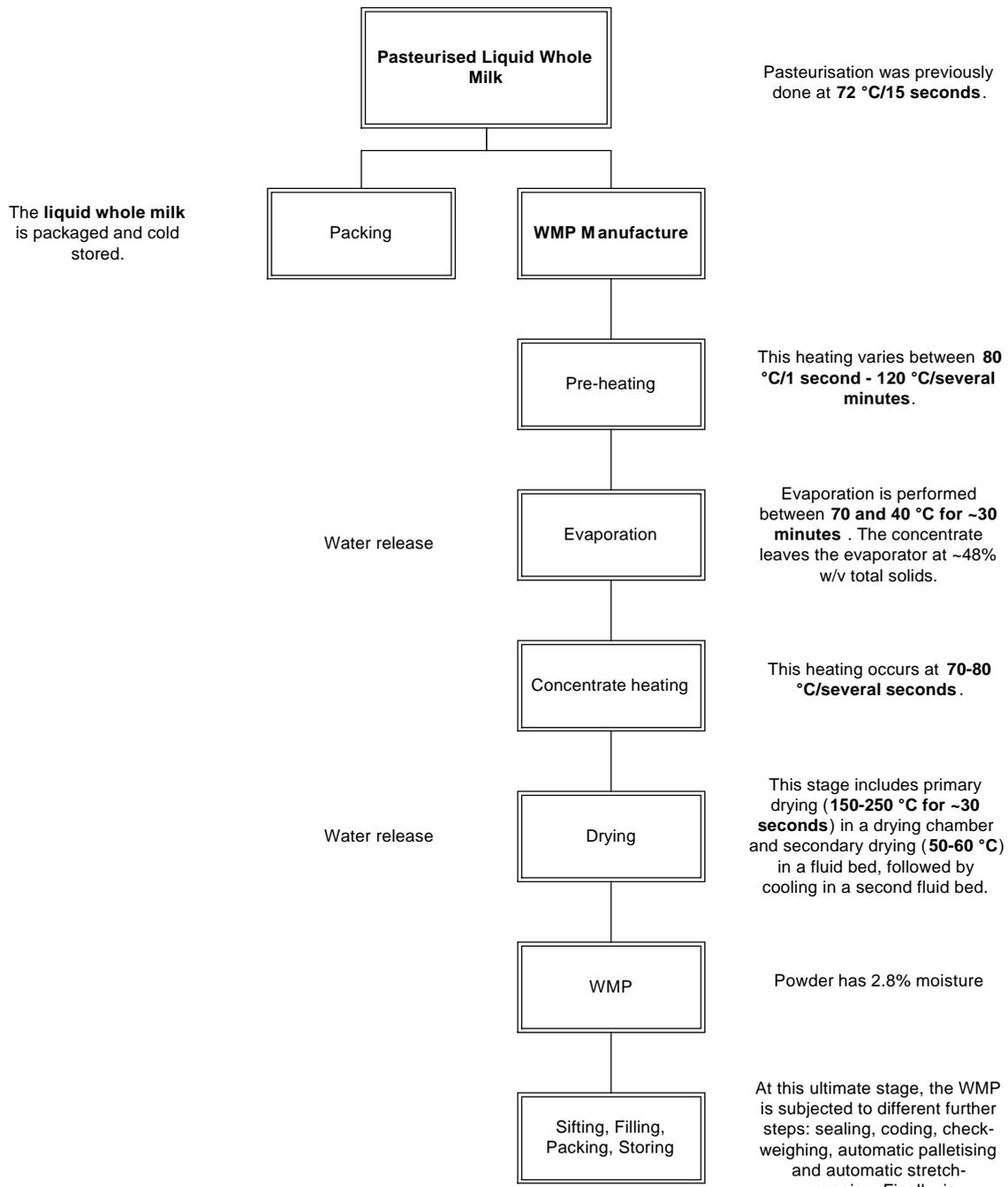


Figure 1 Typical process flow for liquid milk and WMP manufacture¹

¹ The process flow for SMP is essentially the same, but it is performed on pasteurized liquid skim milk.

Discussion

The pathway provides a framework to evaluate the likelihood that EN are present in WPM and SMP. It showed a number of key heating stages that should effectively inactivate enterococcal bacterium. We hypothesize that, provided quality raw milk is used, HTST pasteurization and subsequent milk powder manufacturing steps are appropriately carried out, followed by proper storing conditions, it is unlikely that EN will be present in WPM and SMP products. Therefore, it is unlikely that people will be exposed to EN as a result of consuming WPM and SMP products. We intend to investigate this further by using this pathway to qualitatively estimate the likelihood that a consumer will be exposed to EN as a result of consuming WPM and SMP products.

References

- Cogan, T.M., Barbosa M., Beuvier, E., Bianchi Salvadori, B., Cocconcelli, P.S., Fernández, I., Gomez, J., Gomez, R., Kalatzopoulos, G., Ledda, A., Medina, M., Rea, M.C., and Rodríguez, E. (1997). Characterization of the lactic acid bacteria in artisanal dairy products. *Journal of Dairy Research*, **64** (3), 409-421.
- Franz, C., Holzapfel, W., and Stiles, M. (1999). Enterococci at the crossroads of food safety? *International Journal of Food Microbiology*, **47**, 1-24.
- Franz, C., Stiles, M.E., Schleifer, K.H., and Holzapfel, W.H. (2003). Enterococci in foods-a conundrum for food safety. *International Journal of Food Microbiology*, **88** (2-3), 105-122.
- Giraffa, G. (2002). Enterococci from foods. *Fems Microbiology Reviews*, **26** (2), 163-171.
- Giraffa, G. (2003). Functionality of enterococci in dairy products. *International Journal of Food Microbiology*, **88** (2-3), 215-222.
- Hill, B.M. and Smythe, B.W. (1997). A study of the microbiological quality of raw milk from individual farms. *New Zealand Dairy Research Institute*, 1-35.
- Kayser, F.H. (2003). Safety aspects of enterococci from the medical point of view. *International Journal of Food Microbiology*, **88** (2-3), 255-262.
- Mannu, L., Paba, A., Daga, E., Comunian, R., Zanetti, S., Dupre, I., and Sechi, L.A. (2003). Comparison of the incidence of virulence determinants and antibiotic resistance between *Enterococcus faecium* strains of dairy, animal and clinical origin. *International Journal of Food Microbiology*, **88** (2-3), 291-304.
- Murray, B.E. (1990). The life and times of the *Enterococcus*. *Clinical Microbiology Reviews*, **3** (1), 46-65.