Modelling Contamination of Raw Milk with Butyric Acid Bacteria Spores

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Modelling contamination of raw milk with butyric acid bacteria spores

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Introduction Raw milk contains low concentrations of bacterial endospores, originating from the farm environment (e.g. soil, feeds, faeces). Spores of *Clostridium tyrobutyricum*, also called butyric acid bacterium (BAB), are of great interest to the dairy industry. They survive milk pasteurisation and cause off-flavours and texture defects in various cheese types. The contamination pathway of BAB spores is well known. Their primary origin is soil. In silage the number of spores will increase if conditions permit BAB growth. The spores are excreted in the cows faeces and are transferred to milk by contaminated teat surfaces. Many factors are involved in the contamination of milk with BAB spores. In this study, the contamination pathway was described using a combination of predictive models. The objective of the study was to quantitatively assess the importance of the different steps of the contamination pathway and to identify the most effective control points.

Materials and methods The contamination of milk was described as a process of sequential unit-operations of carriers of BAB spores, starting with the sources (soil, feeds) and ending with bulk tank milk. For the unit-operations (storage, mixing, concentration, removal) basic mathematical equations were used to describe transmission between carriers. Microbial growth during storage in silage was described as a function of time, pH, a_w and temperature using the gamma-concept (Zwietering *et al.*, 1996). Input variables included controllable variables, which are influenced by the farmers management (e.g. silage quality, silage proportion in ration and teat cleaning strategy and efficiency), and uncontrollable variables (e.g. spore level in soil and amount of dirt on teats before cleaning). Variable values were based on literature data, experimental data available at NIZO and expert estimates.

Results Monte Carlo simulations were performed to quantitatively assess the importance of the different BAB spore sources and transmission steps for contamination of milk. The results showed that the concentration of BAB spores in silage is significantly more important than other factors, including cattle-house and milking hygiene. Obviously, the importance of the latter factors increase when silage with a low spore concentration is fed. The part of the model from faeces to milk was validated with experimental data (Stadhouders and Jorgensen, 1990; Witlox, 1983). Good agreement was observed. Simulations were conducted with fixed BAB spore concentrations in silage and other controllable variables set at either poor, average or optimal management. The results show that with optimal management the critical level of 1 BAB spore per ml of milk is exceeded when silage contains more than 10^6 BAB spores per g (Figure 1). With average management this level is exceeded when silage contains more than 10^4 spores per g.

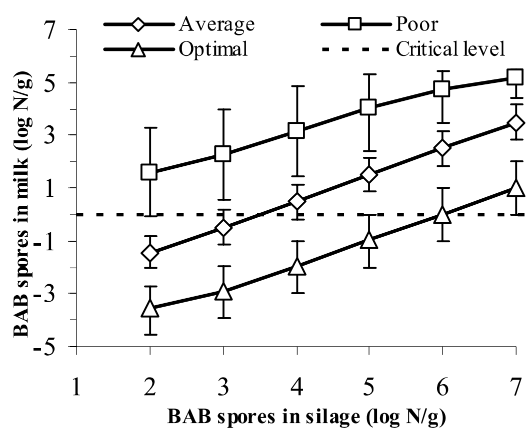

Figure 1 Model simulations with poor, average and optimal farm management

Conclusions The developed model simulates the entire contamination pathway of BAB spores and was applied to predict the effectiveness of control measures. Factors related to cattle-house and milking hygiene proved less important than silage quality. The model can assist farmers in taking effective management decisions with respect to raw milk quality. It may be integrated in on-farm dairy quality management systems.

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