A MATHEMATICAL MODEL SIMULATION OF FUNGI GROWTH ABOVE THE RIND OF HARD CHEESE

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A mathematical model for the simulation of fungi growth on hard cheese surface is presented and is based on previous regression models for mould growth on nonfood materials. Quantification of mould growth in the model is based on the Mould Index (MI), used in the experiments for visual inspection. The model consists of differential equations describing the growth rate of the MI in different fluctuating conditions including the effect of exposure time, temperature, and relative humidity. Temperature and humidity favourable conditions for mould growth are presented as a mathematical model. The MI upper limit value can also being interpreted as the critical relative humidity needed for the first sign of fungi visualization of mould growth on the rind of hard cheese (Grana Padano type). Mould fungi ecosystem in a cheese ripening chamber, is a heterogeneous and not a particularly well defined group of fungi. Typical mould fungi found are Aspergillus, Penicilliun Mucor and Fusarium amongst other species. The growth of fungi has been the subject of experimental research for a long time, but the knowledge thus gathered, has been frequently qualitative in nature. The aim has been to describe the response and the critical conditions for mould growth on these specific surfaces. Most of this previous extensive research has been carried out in constant temperature and humidity conditions but even such models are usually not applicable in arbitrarily varying conditions. The experiments suggest that the possible temperature and relative humidity conditions favoring initiation of mould growth on hard cheese surface can be described as a mathematical model. The initial average concentration of airborne fungal in the ripening chamber was 200 ufc/m^3. The temperature range was 0 to 50°C, and the relative humidity between 75 and 100%. Critical relative humidity (RH_{crit}) required for initiation of mould growth, is a function of temperature and the boundary curve can be described by a polynomial (Ec.1).

$$RH_{crit}[\%] = \{-0.00237T^3 + 0.162T^2 - 3.15T + 100\} \quad T \leq 20°C$$
$$RH_{crit}[\%] = 80 \quad T \geq 20°C \qquad \text{Ec.1}$$

This mathematical model allows calculating the beginning of mould growth on a hard cheese surface exposed to arbitrary temperature and humidity histories. On this basis, it is estimated that the same functional form of the model, could be used in the prediction of mold spoilage in similar substrates, only the numerical values of the coefficients must be re-evaluated (Ec.2).

$$\frac{dMI}{dt} = \frac{1}{6.8\exp(-0.63\ln T - 13.93\ln RH + 65.98)} \quad \text{para MI} < 1 \qquad \text{Ec.2}$$

The total temporal scale (32 weeks) is appropriate to be applied to a total ripening time in hard cheese storage.

Keywords: mathematical modeling, hard cheese, mould fungi growth