Technical note

Thermal stabilization of non-concentrated tomato products

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Industrial processes for thermal sterilization of preserved foods aim at the microbiological and enzymatic stabilization of products in order to enable preservation at room temperature and therefore later consumption.

With microbiological stabilization the probability of microbial survival and thus spoilage of preserved foods is reduced to levels that are considered acceptable.

The heat treatment required to stabilize a preserved food product microbiologically can be determined when the following factors are known:

1) heat resistance (D_T and z), in that substrate, of the most heat resistant microorganism that can contaminate it and that is able to grow;

2) the real or estimated concentration of the cells (or spores) of this microorganism .

In addition, acceptable survival probability (N_F) must be defined in terms of "probability of non-sterile unit" *(PNSU)*, intended as determination of the endpoint of the industrial preservation process.

The time required to obtain a determinate microbial inactivation at a given temperature is defined as **sterilizing effect** or **lethal effect.**

The sterilizing effect (or lethal effect) (F_T) can be expressed by the following formula:

$F_T^z = D_T \times (\text{Log } N_0 - \text{Log } N_F) = D_T \times n$

Where D_T = time for decimal reduction of microorganism to be inactivated or of reference microorganism at a constant temperature T;

N_0 = initial microbial concentration (measured or estimated);

N_F = microbial survival probability considered acceptable;

n = number of resulting decimal reductions.

To calculate the sterilizing or lethal effect to be applied to a food, it is therefore necessary to identify the reference microorganism. To this end foods are subdivided according to pH value, in relation to the different development ability and the different heat resistance of the microorganisms on the basis of this parameter.

The sterilizing effect F_T is calculated at the reference temperature T of 85 °C for preserved foods with pH < 4.2 and for tomato paste, 100 °C for preserved foods with 4.2 ≤ pH < 4.6 and at a temperature of 121 °C for preserved foods with pH ≥ 4.6.

In non-concentrated tomato preserves (4.2 ≤ pH < 4.6) microorganisms with poor heat resistance can develop, such as lactic bacteria, enterobacteria, yeasts and moulds and some species of sporogenous bacteria such as "butyric clostridia" (*Clostridium pasteurianum, C. butyricum, C. acetobutylicum,* ecc.), *Bacillus coagulans* and, more rarely, *Paenibacillus macerans*, *P. polymyxa* and *Thermoanaerobacterium thermosaccharolyticum*.

Vegetative cells are rapidly inactivated already at temperatures around 60°C: the D_{60} values are close to 1-5 minutes.

The mesophilic *Bacillus* and *Clostridium* species that can develop in acid products form spores with lower heat resistance values compared to other species of the same genus, however they are resistant to treatments with temperatures close to 100°C. Stabilization of non-concentrated acid products can be achieved only by inactivating or inhibiting the spores of such bacteria. Non-concentrated tomato products, especially peeled tomatoes, are frequently subject to spoilage by butyric clostridia, gas-producing bacteria that cause the swelling of the container for H_2 and CO_2 production. The time for decimal reduction of *C. pasteurianum* spores (the most heat resistant among butyric clostridia) in tomato juice with pH = 4.5 is equal to 0.65 minutes at 100°C, with z = 10°C.

The maximum level of contamination found in fresh tomatoes was approximately 10^4 spores per gram.

Therefore stabilization of peeled tomatoes and similar products requires the application of times and temperatures that take into account the maximum contamination of the fresh product and the final probability of spoilage considered acceptable.