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THE CALCULATION OF THE LETHAL EFFECT OF HEAT STERILISATION OF CANNED FOODS AND OPTIMIZATION OF NUTRIENT RETENTION

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Summary

The modern sterilisation process aims to destroy microbiological life and to inactivate enzymes in the product with the least possible effect on the sensory properties and nutritive value of the product. The process must comply with the requirements on food safety, what is provided by control of lethal effect of the thermal sterilization expressed with F-value. From the view point of human nutrition, it is appropriate that the process conditions secure the maximum nutrient retention. For optimization of this process, C-value parameter is used for the evaluation of the effect of heat on the nutrients. This paper submitts the calculation of the lethal effect of heat sterilisation of canned foods with use of F-value and optimization of nutrient retention with use C-value.

Introduction

The treatment and preservation of foodstuffs has already been one of the main activities of the human society. Thermal processing of food is the most prominent way of preserving food and of making it edible. The primary object of the thermal processing of canned foods is to destroy living microorganisms capable of causing deterioration of the food or endangering the health of the consumer. It is important to heat the food in such a way that it is satisfactorily preserved and still retains its expected taste, aroma and appearance, together with its functional properties. Moreover, the biological value of the food product must be taken care of, so that as much as possible of its nutritional properties will remain when the food product reaches the consumer [2,10].

Process evaluation

Theoretical principle of the thermal process assessment is based on the thermoinactivation kinetics of decisive microorganism (Fig. 1). Then, the efficiency of the thermal preservation process (F-value for canned product) is determined from the experimentally found time-temperature profiles (Fig.2)

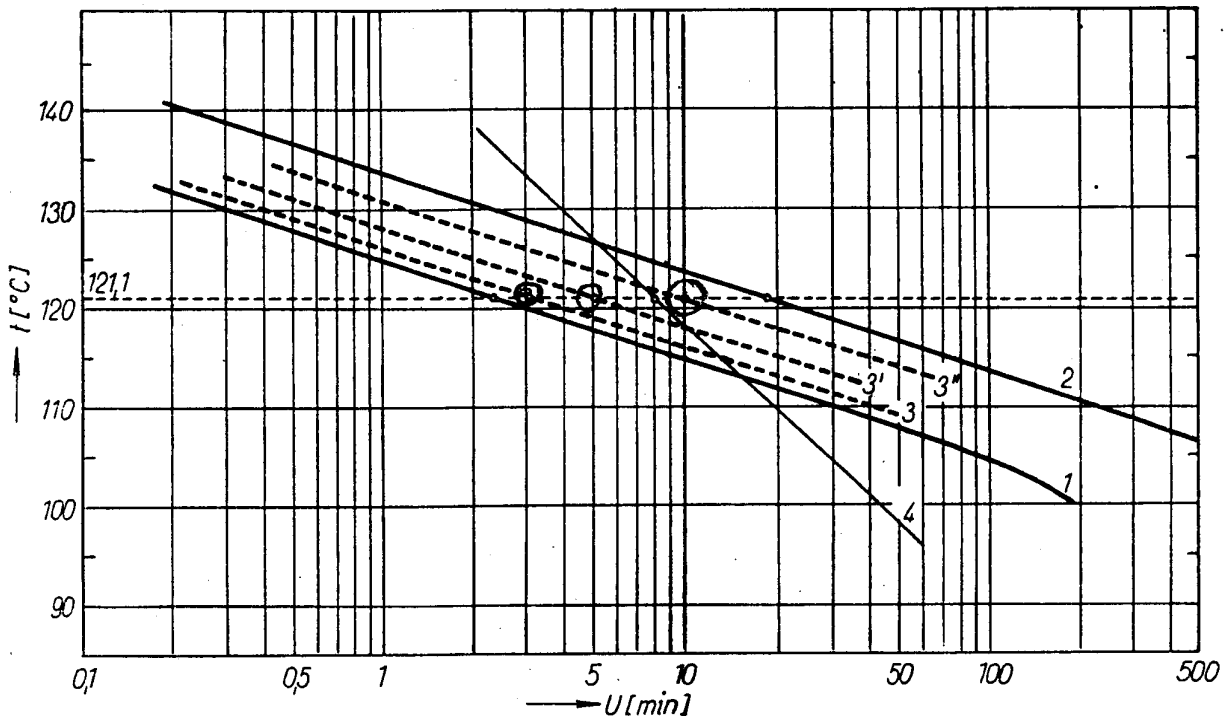

Fig.1 Thermal death time (TDT) curves for microflora in low-acid foods [1]

1 - normally resistant spores of bacilli and clostridia
2 - very resistant spores (of thermophilic sporulates)
3 - Clostridium botulinum A,B at pH < 5,0
3' - Clostridium botulinum A,B at pH 5 - 5,5
3"- Clostridium botulinum A,B at pH 5,6 - 7
4 - pea peroxidases

The conditions of thermal sterilization depend, above all, on composition and properties of the product, type of sterilizing equipment, heat penetration into the food as well as on initial concentration of microorganisms, their heat resistance and conditions of storage of the product after the sterilization process. On the basis of the given factors, sterilizing regimes are given individually for each type of the product and size of the package. Sterilizing conditions comprises on the data, assigning the combination of sterilising temperature and time, as well as pressure data (at pressure sterilization) for single phases of the total process of heating-up, holding and cooling down. Sterilization must provide the achievement of required minimal sterilization effect in the whole batch (charge) or in the whole produced volume [7].
In the formulation of heat sterilisation for canned foods, the most difficult problem is to evaluate the lethal effect of the period during which the temperature of the can contents is rising to its maximum; especially where the heat-penetration rate is slow the temperature continues to rise during all or most of the process time [2].

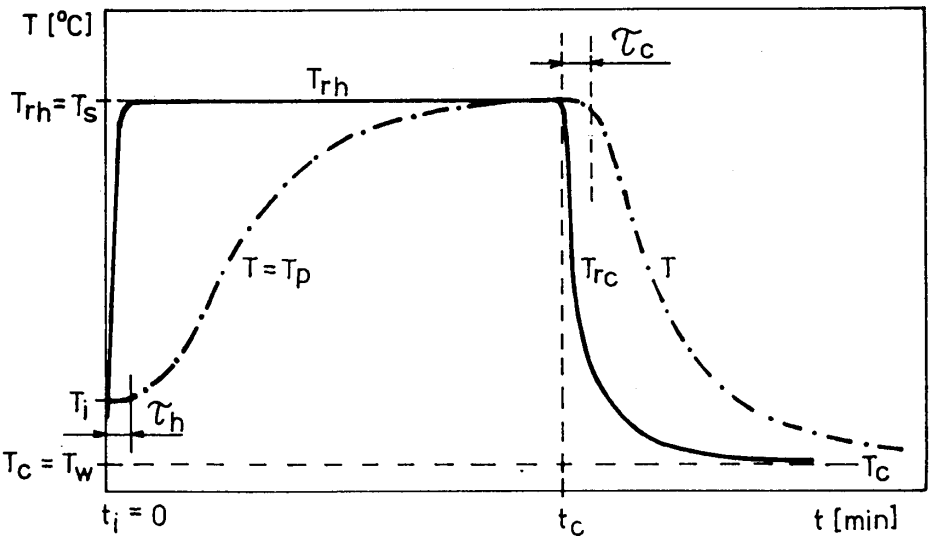

Fig. 2 Specified data for the scheduled process (heat penetration curve)[7]
—— **retort,** — . — **product, T- temperature in °C, t - process time[min]**

The main procedure used for estimating the lethal effect of the process is measurement of the temperature at the point of greatest temperature lag within the can and integration of the lethal effects at this point by graphical or mathematical procedures [1,3,5,9].
The scheduled process is prepared with close attention to the actual conditions in the retorts. In order to define the heat-penetration curve completely it is necessary, however, to start thermocouple readings at the commencement of the process. It is important to note that for some packs quality considerations call for a process in which the margin of safety is small, and in such cases a change in the initial temperature of the can contents, or the cooling rate, may render the process ineffective.
The classical methods developed by Ball [5] may be used for calculating processes for any size of can or retort temperature provided the thermal death-times and rates of heat penetration approximate to straight lines when plotted on semilog paper. Most of the reference data to be found in the literature is on this basis [1,3,5,7] . Ball defined the TDT-curve by reference to the coordinates of an arbitrarily chosen point (*termed F*) and the slope of the line (*z-value*). The hypothetical curve passing through 1 minute at T_r = 121,1°C (for low-acid foods) is used for process calculations and gives the times and temperatures corresponding to F = 1. The times at any temperatures other than 121,1 °C are designated F_i and are related to each other in a manner dependent upo the slope of the curve (*z-value*) [2]:

$$F_i = \log^{-1} \frac{121.1 - T}{z}$$

The reciprocal of F_i is the lethal rate expressed as the number of F units per minute corresponding to the temperature T (°C).

Optimization of a thermal process

For commercial sterilization, optimization of a thermal process is based on the fact, that the rate of destruction of nutrients is less dependent on the temperature than the rate of destruction of microbial spores. To be able to evaluate the influence on

quality of different sterilisation conditions, it is necessary to calculate the combined influence of time and temperature on rheological, chemical and sensory properties.

The changes in food composition during the heat treatment are expressed by so called ***C-value*** *(cook value)*. This value characterises the product cooking degree and enables to compare the changes caused by denaturation of nutrients in the given product at certain thermal intervention[8]. The method comes from the presupposition that the considered changes in nutrients caused by denaturation take place according to the kinetics of the first order reaction. It appears, that the dependance of nutrients denaturation rate on temperature can be expressed in the same way for microorganisms and enzymes - by the *D* and *z* values, i.e. the slope of the straight lines for denaturation of these components is in the linear dependance on denaturation of food with the thermal intervention. The higher is the z_c value, the more resistant is the given food component against the influence of thermal energy.

Leonard et al. proposed a cook value (C-value) which is calculated in analogue to the sterilisation value (F-value) as follows :

$$C = \int_0^t \frac{T(t) - 100}{10^{Zc}} \, dt$$

The definition is given including a formula comprising an expression *z-value* z_c (^oC), being a value of straight line for denaturation of food nutrients and expressing a temperature interval necessary for running of this straight line through only one logarithmic cycle. In general is mostly used a z_c-value equal 33 ^oC as an approximation for chemical changes. In fact, very few experimental measurements of C- and z_c-values for different foods have been reported in the literature [2,3,4,6,7,8].

When the thermosterilisation process from the point of maximal retention of nutrients shall be optimized, it is necessary to find the minimum C-values for the given F-value.. The presupposition takes in consideration that when C-value is minimal for F = const., then also ratio C/F is minimal. But the margin of sterilization temperature is valid, because C-value should be minimal only at very high temperatures with subsequent achievement of F-value. The most suitable is to look for the optimal temperature and time for F- and C- values, that are afore known. F-value is determined according to the character of the product. Minimum C-value is determined on the basis of *z*-value for the selected components [7,9].

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GROWING OF AMARANTH AND ITS IMPORTANCE IN MAN NOURISHMENT

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Summary

Amaranthus belongs to pseudo-cereals and was grown by ancient Mayas (Moudrý, et. al.,1999) for whom it was a sacred plant. Amaranthus is an annual dicotyledonous plant. Plants have a
bulky pile root with a firm often 2 m high stem (depending on genotype)and rich panicle of varied color. It belongs to plants with C 4 cycle, i.e.plants with high demands on temperature. Growth of plants is slow in the beginning of season and therefore very sensitive to weeds. Convenient front-crop are rape, leguminous plants, cereals (except rye). Soil preparation in spring season has to be good with respect to very small seeds. Seeds are sown at dose of 1.5-2.0 kg/ha in depth max. to 1.5 cm and row distance of 20-35 cm. Convenient period of sowing under our conditions is usually at soil temperature above 12 C in the middle of May. Weed control is possible to do by harrowing. In case of bad climatic conditions (crust or wet soil)