

# IMPLEMENTATION OF SOME MATHEMATICAL APPROXIMATION METHODS OF FUNCTIONS FOR STUDY OF THE FACTORS WHICH INFLUENT THE FERMENT ACTIVITY OF BEER YEAST

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Choosing of a certain beer yeast stem for beer obtaining, in specific conditions to lay in one's stock of raw materials, of endowment and of used technology, is achieved taking into account the main specific features of the beer yeast: final fermentation degree and the fermentation speed, capability to assimilate the substances which participate in metabolism, multiplication efficiency, sedimentation and flocculation capability, spectrum and quantity of secondary products of fermentation with implications in the beer taste and aroma, deterioration and contamination resistance.

# The factors which influent the beer yeast fermentation activity

The rejoinder life cycle, determined by number of complete divisions of each individual cell is genetic controlled, but influenced by medium conditions.

The chronological life cycle, defined as maximum outliving time of the cells maintained in the stationary growing stage and characterized by a temporary loosing of multiplication capability due to the nutrients absence, constitutes an important controlling instrument of degeneration at the macromolecular level and of cell death rate.

The study object is to evaluate in which measure the supplementation of yeast inoculums with linoleic acid succeed to minimize the negative effect of the thermal shock stress factor on the one side, and the subduing to repetitive running of fermentation cycles, on the other side.

The study proposes to find the most efficient way to grow the intracellular trehalose content through beer yeast suspending into trehalose solutions by different concentrations, at different thermo-stating temperatures and in different contact times, taking into account that this technique allows the passive transfer of exogenous trehalose inside the cells both at a new propagated cell population, and at cells resulted from an industrial inoculum.

The fermentation activity of yeast and implicit the beer quality is influenced by three great categories of factors:

- the used yeast strain;
- the chemical composition of unfermented beer;
- the fermentation conditions.

Due to the reduced volume, the yeast cell, as all microbial cells, is extremely sensible at the variation of bio-synthesis parameters, especially at the concentration variations of nutritive substratum. The nutrient concentration increasing determines, usually, a stimulation of microbial metabolism, but only till a limit value over that the concentration increasing even remain without effect, or has a negative influence on cellular physiology through substratum inhibition or through the osmotic pressure increasing.

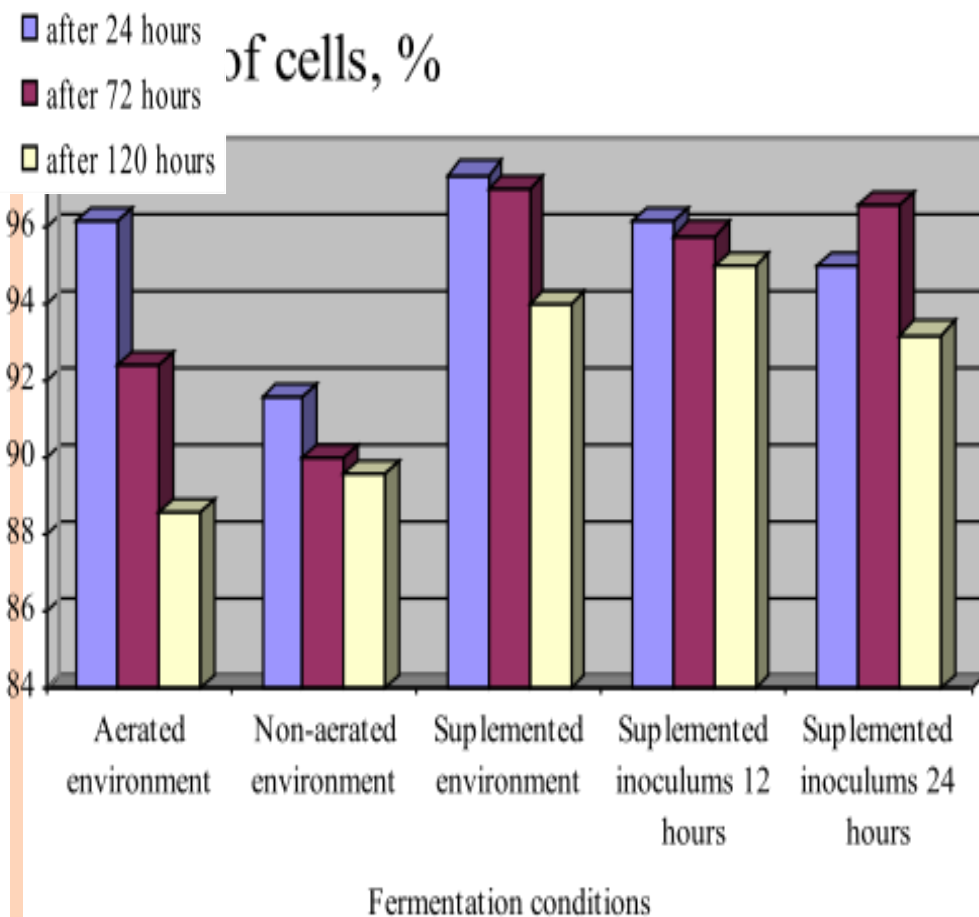
The fermentation conditions are very important for rapid starting and fermentation in good conditions of the unfermented beer:

- chosen propagation method;
- yeast doze chosen at impregnation, correlated with the impregnation temperature and multiplication degree during the fermentation process, correlated with the impregnation doze and fermentation duration;
- aeration and agitation;
- fermentation temperature and pressure;
- chosen fermentation duration and dimension and form of fermentation recipients;
- getting in, purification and cheeping of the yeast.

Temperature is one of the most important physical parameters, deep involved, through its effects, in the increasing of fermentation capability. The temperature variations have effect over the efficiency of substratum transformation, over the nutritive requests of the yeast and over the fermentation speed.

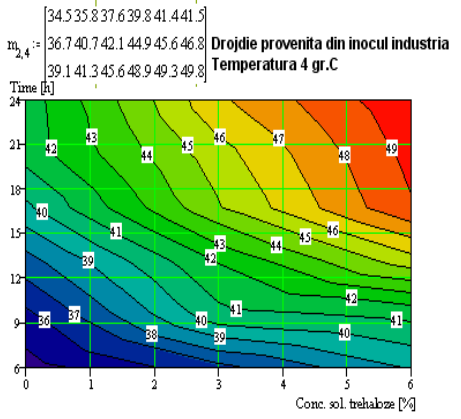
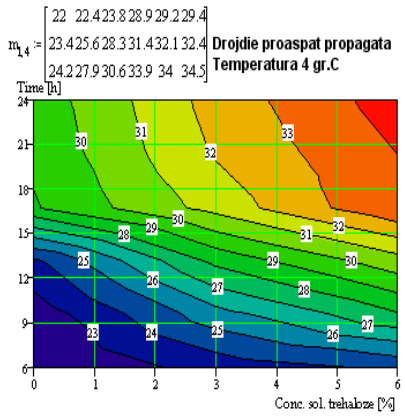
Repetitive re-impregnations affect the fermentation capability of beer stem because occur changes in cellular wall physiology, is affected the integrity of the membrane mitochondrial functions.

The influence factors with physical-chemical character (osmotic pressure, hydrostatical pressure, hydrodynamic detrusion force during manipulation, pH, temperature, content of oxygen, ethanol, carbon dioxide), and the nutritional influences (HG unfermented beers, required sources of carbohydrates and azote, the content of inorganic zinc and magnesium ions, of vitamins and phosphor) have an outstanding influence over the cellular growing and fermentation capability of yeast.



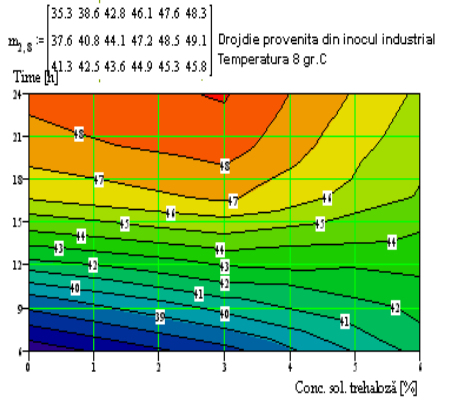
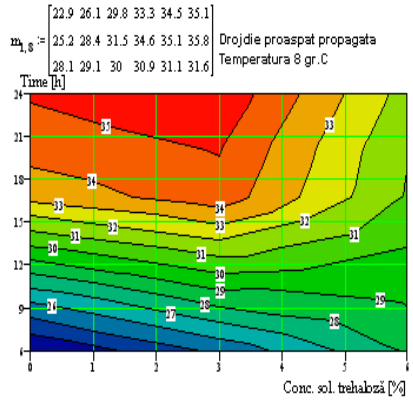
## of cells from fermented conditions

The viability of cells is the lowest in conditions offered by non-aerated medium. In the aerated medium, viability is initial low, but decreases against the end of the fermentation. The greatest number of viable cells was registered in the medium in which was linoleic acid, even under the form of a supplement for medium, or under the form of a supplement for inoculums yeast.



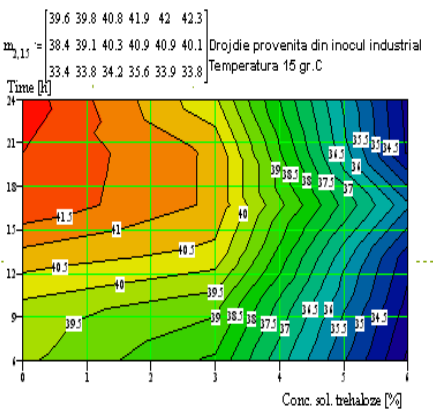
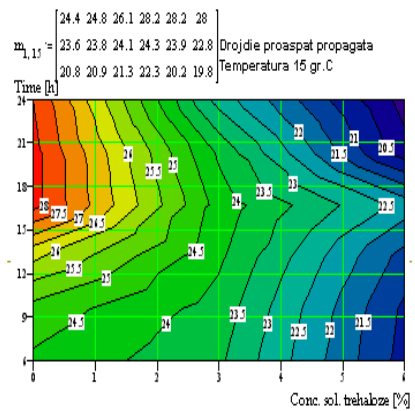
$\text{mean}(m_{1,4}) = 28.556$   
 $\text{median}(m_{1,4}) = 29.05$   
 $\text{stdev}(m_{1,4}) = 4.032$   
 $\text{var}(m_{1,4}) = 16.259$   
 $\text{cvar}(m_{1,4}, m_{2,4}) = 17.818$

$\text{mean}(m_{2,4}) = 42.3$   
 $\text{median}(m_{2,4}) = 41.45$   
 $\text{stdev}(m_{2,4}) = 4.568$   
 $\text{var}(m_{2,4}) = 20.871$   
 $\text{corr}(m_{1,4}, m_{2,4}) = 0.967$



$\text{mean}(m_{1,8}) = 30.728$   
 $\text{median}(m_{1,8}) = 31$   
 $\text{stdev}(m_{1,8}) = 3.582$   
 $\text{var}(m_{1,8}) = 12.83$   
 $\text{cvar}(m_{1,8}, m_{2,8}) = 13.603$

$\text{mean}(m_{2,8}) = 43.856$   
 $\text{median}(m_{2,8}) = 44.5$   
 $\text{stdev}(m_{2,8}) = 3.836$   
 $\text{var}(m_{2,8}) = 14.718$   
 $\text{corr}(m_{1,8}, m_{2,8}) = 0.99$



$\text{mean}(m_{1,15}) = 23.75$   
 $\text{median}(m_{1,15}) = 23.85$   
 $\text{stdev}(m_{1,15}) = 2.574$   
 $\text{var}(m_{1,15}) = 6.624$   
 $\text{cvar}(m_{1,15}, m_{2,15}) = 7.403$

$\text{mean}(m_{2,15}) = 38.378$   
 $\text{median}(m_{2,15}) = 39.7$   
 $\text{stdev}(m_{2,15}) = 3.181$   
 $\text{var}(m_{2,15}) = 10.117$   
 $\text{corr}(m_{1,15}, m_{2,15}) = 0.904$

# The evolution of intracellular concentration at constant temperature

# Conclusions

The obtained data after comparative study of yeast cells supplemented or not with linoleic acid that fermented in aerated, non-aerated or non-aerated but supplemented with linoleic acid mediums, indicate:

- The yeast contained in the supplemented inoculums demonstrated a growing and led to a fermentation degree comparable with that yeast which fermented the aerated non-fermented yeast.
- The cells from supplemented medium and those that belong to inoculums supplemented with linoleic acid with a contact time of 12, respectively 24 hours are characterized by a certain progressive dynamic regarding the fermentation intensity.
- The quantity of generated biomass is greater in the supplemented medium and in that fermented by cells from inoculums supplemented with linoleic acid.

- The greatest number of viable cells is recorded even in the medium in that was presented the linoleic acid, or in that fermented by cells supplemented with linoleic acid.
- The trehalose intracellular content of the cells supplemented at a contact time of 12 hours, at the initial moment clear-cut superior, decrease drastically in the first 24 hours of fermentation, what indicates the increasing of the cells' capability to synthesize the trehalose, during the time of contact with the linoleic acid, to use as reserve-carbohydrate in lag stage, but also to remake the reserve after 120 hours of fermentation in a greater measure then the cells from aerated, non-aerated and supplemented with linoleic acid medium.
- The fermentation degree of the aerated non-fermented beers or of those impregnated with inoculums supplemented with linoleic acid is lower, but the differences are very small.
- The capability to reduce the diacetyl, correlated with the beer's vitality, is clear-cut superior at the cells from the inoculums supplemented with linoleic acid.
- The results indicate as alternative variant for medium aerating the variant of supplementing the beer inoculums with linoleic acid.

THANK YOU !

If you want to know more about the mathematical approximation method used in this paper I'm waiting your questions.

If you want to know more about beer yeast you can contact Rodica Rotar ([rodicas@usv.ro](mailto:rodicas@usv.ro)).

If you want to know more about beer you can taste more kind of beer.