ON THE INFLUENCE OF TEMPERATURE UPON THE GROWTH OF ASPERGILLUS SYDOWI SARTORY IN CONCENTRATED BRINES

by

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§ 1. Introduction.

In two publications WALTER (1925—1931) expressed his opinion that the growth of even the most drought-resistant moulds is no longer possible below a relative vapour-pressure of 85%. The hydrature-minimum, as WALTER (1931) expresses it, lies in this case at about 85% and according to him it is of no consequence whether the moulds are cultivated in air of a certain humidity or in sugar-solutions of a corresponding lowering of vapour-pressure. Only for solutions with concentrated electrolytes he assumes departures, which render growth below the hydrature-minimum also possible.

During my stay in the tropics I observed that dry copra, which had been kept over moist household salt (hydrature abt 76%), began to grow mouldy after some time, which is in contradiction with Walter's statements. Presumably the higher temperature (abt 28° C) acted a part. It also appeared from an article by ZEUCH (1934) on the growth of *Pleurococcus* at different atmospheric humidity and temperature that the growth at 20—30° C was possible with a much lower humidity as with lower temperatures. ZEUCH even observed growth at a relative atmospheric humidity of 48%.

In Europe I had the opportunity of making some simple experiments on this subject. The result appeared to me of sufficient interest for publication. I want to express my thanks to Professor ARISZ for the hospitality received at the Botanical Laboratory of Groningen.

§ 2. Material and Method.

Erlenmeyer flasks of a content of 100 cc were used. Matters were conducted as follows: first a certain quantity of salt was weighed in a flask, then inoculation took place with a small piece of mouldy copra. Next the liquid nutrient was pipetted, each time 10 cc extract of bananas. The liquid nutrient was prepared by boiling a peeled banana cut up small, during 1 hour in 2 liters of water and straining it through a cloth after adding a particle of lime.

Immediately after adding the liquid nutrient the flask was closed with a paraffined cork and the edges sealed with paraffin. Then the flasks were placed into thermostats of various temperatures. After one month the experiment was interrupted and the growth checked.

§ 3. Experiments.

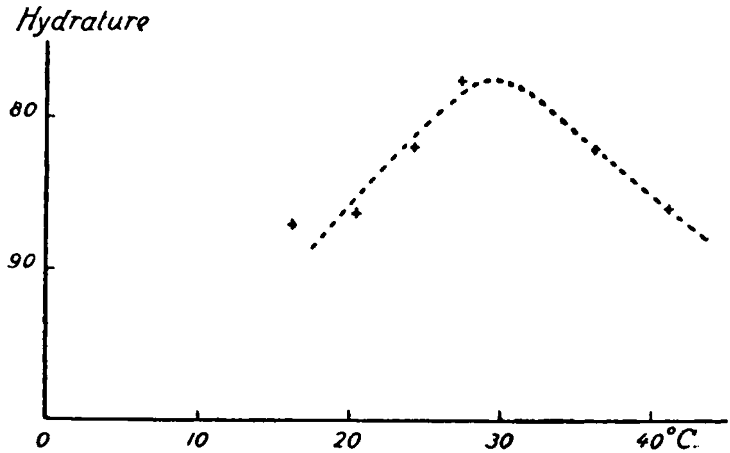
In the control-series containing no salt an abundant growth of bacteria was always observed. In the less concentrated brines of 0.6 to 1.9 grams of salt pro 10 cc liquid nutrient, many kinds of moulds grew, especially Aspergilli; growth of bacteria, however, was hardly observed.

In the high concentrations, in which growth was just possible, an Aspergillus with greyish-green spores is always present, by the side of *Torula Sacchari*. As a standard only the above-mentioned Aspergillus was used, determined at Baarn as *Aspergillus Sydowi* Sartory.

The subjoined table shows the result of the experiment. A + sign indicates a distinct growth of Aspergillus after 1 month.

Gr NaCl pro 10 cc extract	Hydrature in %	Temperature °C 16	20	24	27	36	41
5 (saturated)	75.8						
3.2	78.4				+		
2.9	81.5			+	+	+	
2.7	83.0			+	+	+	
2.5	84.3			+	+	+	
2.3	85.6		+	+	+	+	+
2.1	86.8	+	+	+	+	+	+
1.9	88.3	+	+	+	+	+	+
1.3	93.0	+	+	+	+	+	+
0.6	96.8	+	+	+	+	+	+
0	100.0	+	+	+	+	+	+

In the subjoined graph the above has been graphically represented.



On the abcissa the temperature has been given and on the ordinate the hydrature at which growth still appeared to be just possible.

It is obvious that there exists a strong dependence on the temperature, with an optimum at abt 30° C. At this temperature it is therefore possible for Aspergillus to grow in a more concentrated solution than at the other temperatures.

§ 4. Discussion.

In deviation from WALTER's opinion (1925) and in correspondence with ZEUCH's observations (1934) it appears that the hydrature-minimum is dependent on the temperature.

On decrease of hydrature a gradual fall in the rate of the vital processes occurs, in casu growth. The curves WALTER gives for moulds clearly point in this direction.

Lately BELEHRADEK (1932), on the ground of various considerations and facts outlined the more general significance of diffusion, as a limiting factor of most vital processes.

Belehrádek explains this as follows: As most processes are of a catalytic nature three sub-processes may be considered.

I. Transport (diffusion) of the substances to the catalysator-surface.

II. Reactions of the substances.

III. Transport (diffusion) of the substances after reaction away from the surface.

The rate of reaction is determined by the slowest of the three processes.

When the diffusion has a limiting influence a close connection with viscosity may be expected. For according to the Einstein-Smoluchowsky formula, diffusion is inversely proportional to viscosity. A temperature-curve will then render in the main an inverse plasm-viscosity-curve.

If the hydrature of the plasm is strongly diminished it may be expected, analogous to data from the colloid chemistry, that the viscosity of the plasm strongly increases and consequently diffusion is most likely to work limiting. On increasing the concentration of the medium a fall in the rate of growth is found, (WALTER). Going by BELEHRADEK's data, we may even assume in my opinion, that at the hydrature-minimum diffusion is so slight that growth is rendered impossible.

When at a certain temperature the hydrature-minimum has been fixed, the viscosity, as is known, will change at a change in temperature and consequently likewise the diffusion and the hydrature-minimum itself. For on increase of viscosity more growth is possible owing to greater diffusion, whereas on increase of viscosity the reverse takes place.

The course of viscosity in *Allium* was ascertained by PRUDHOMME VAN REINE (1935) who found an optimum of 25° C. This corresponds fairly well with the values found by me, of 30° C, if we take into account that the diffusion itself also slightly increases with a rising temperature and consequently the top of the curve is somewhet shifted. In this case BELEHRADEK's hypothesis gives a plausible explanation of the phenomena observed.

§ 5. Summary.

The hydrature-minimum of *Aspergillus* shows a strong dependence on the temperature. The lowest hydrature-minimum is reached at abt 30° C and 77% relative humidity.

§ 6. Literature.

1. Belehrádek, J. 1932. A propos de la base theorique des coefficients de temperature des processus protoplasmatiques.

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