5624

Effect of Heat on Mold Spores.

G. I. WALLACE AND F. W. TANNER.

From the Department of Bacteriology, University of Illinois, Urbana.

Because of their wide distribution and ease of dissemination, molds always present a problem in the preparation of foodstuffs that are not to be consumed immediately. The changes produced in foods by molds are in general very undesirable. As heat is the most common way of preserving foods, it was thought desirable to know something about the thermal death times of molds. Thom and Avery[1] found that *Rhizopus nigricans* and *Oidium lactis* were killed in pasteurized milk at 54.5°C. (130.1°F.) in 30 minutes, but that most strains of *Aspergillus* and *Penicillium* resisted this temperature and were killed at 60°C. (140°F.) for 30 minutes.

Since 30 minutes is the customary pasteurization time, and since this experiment was carried out mainly to study the effect of pasteurization, no tests were made at intervals more frequent than 30 minutes. Streider and McClellan[2] studied the thermal relations of molds in bread. They submerged flasks containing mold suspensions in a water bath at 20°C. (68°F.). The temperature was slowly raised to 100°C. (212°F.) so that the elapsed time was 35 minutes. This was done to simulate the temperature obtained when baking bread in the ovens. No molds survived. Loaves of bread that had been exposed to molds were heated to 110°C. (230°F.) at 15 pounds pressure, for 30 seconds, and exposed to live steam for 4 minutes. In the first case, *Rhizopus* and *Aspergillus* species survived, while in the latter, *Aspergillus* species only survived. Complete destruction of the mold was almost attained, as there were very few mold colonies on the plates made from this last experiment. Using the same procedure, loaves were then exposed to dry heat at 120°C. (248°F.) for 10 minutes. Both *Aspergillus* and *Penicillium* species withstood this exposure, although most of the cells were destroyed.

Molds in meat have also been studied. Roderick[3] found that all molds were killed in frankfurters when they were heated in water at 60°C. (140°F.) for 10 minutes. Lewis and Yesair,[4]

[1] Thom, C., and Ayers, S. H., *J. Ag. Res.*, 1916, **6**, 153.

[2] Streider, J. W., and McClellan, R. N., *Baking Tech.*, 1922, **1**, 230, 282.

[3] Roderick, L. M., 1926. Quoted from Lewis and Yesair.

[4] Lewis, W. L., and Yesair, J., Bull. published by Institute of American Meat Packers, 1928.

using temperatures of 50°C. (122°F.), 55°C. (131°F.) and 60°C. (140°F.), exposed pure cultures of molds for periods of time ranging from 5 minutes to one hour. At 50°C. (122°F.) all molds studied except 2 *Aspergillus* species, *Rhizopus nigricans* and *Fusarium,* survived the one hour exposure. Of the latter group they were destroyed in 30, 25, 15 and 5 minutes respectively. When the temperature was raised to 55°C. (131°F.), only *Monilia sitophila* survived the hour exposure. *Mucor racemosus* was destroyed in 25 minutes, *Aspergillus niger* in 20 minutes, *Penicillium expansum* in 15 minutes and *Alternaria tenius* and 2 other *Aspergillus* species in 5 minutes. None of the organisms survived 60°C. (140°F.) for 5 minutes.

In the following study, mold spores from pure cultures were suspended in 1, 3 and 6% salt solutions; 10, 25 and 50% sugar solutions; juice from pitted red cherries in syrup, and distilled water. *Rhizopus nigricans, Mucor mirus, Aspergillus niger, Oidium lactis* and *Alternari solani* were the molds studied. DeKotinsky tubes were filled and sealed in the flame, containing 2 cc. of the mold suspensions. These sealed tubes were submerged in water baths at temperatures of 50°C. (122°F.), 55°C. (131°F.) and 60°C. (140°F.). At 5 minute intervals, a tube of each mold was taken out and submerged in cold water. As soon as cooling was assured, the tubes were wiped with disinfectant, broken and 1 cc. of the contents added to a sterile petri dish for culture.

With *Rhizopus nigricans* the salt solution, cherry juice and distilled water suspensions all acted in a similar way. At 50°C. the organisms were completely destroyed within 20 minutes, and at 55°C. within 10 minutes. In the sugar solution suspensions it took 30 minutes at both 50°C. and 55°C. to completely destroy the cells. The percentage of sugar apparently did not influence the death rate, as the action in all 3 solutions was practically the same. Results of the study of *Aspergillus niger* were very much like those obtained from *Rhizopus nigricans,* except that a slightly higher temperature was necessary. In the salt solution suspensions it took 30 minutes at 55°C. (131°F.). With *Alternaria solani* and *Mucor mirus* the results showed about the same thermal death times as those obtained with *Rhizopus nigricans* and *Aspergillus niger,* except that the salt solution suspensions were the hardest to destroy. Here the salt solution suspensions resisted 50°C. for 30 minutes, but were killed within 10 minutes at 55°C. and the sugar solution suspensions were destroyed within 25 minutes at 50°C. and 5 and 10 minutes at 55°C. In the *Trichothecium* species there was no practical difference be-

tween the salt and sugar solution suspensions. It was destroyed within 30 minutes at 50°C. and 5 minutes at 55°C. *Oidium lactis* resisted 60°C. for 30 minutes in all suspensions.

In general, these results agree with those of previous investigators, that, although species of molds vary slightly in their thermal death times, a temperature of 60°C. for 5 minutes is usually sufficient to assure complete destruction. Exceptions were observed in *Aspergillus niger* and *Oidium lactis*. *Aspergillus niger* resisted 60°C. (140°F.) for 10 minutes in some cases, and *Oidium lactis* survived after 30 minutes exposure. From the data it seems that the molds studied react differently towards sugar and salt. In some cases, the sugar protected the organisms more than the salt did, *e. g.*, *Aspergillus niger* and *Rhizopus nigricans;* and in the others, the salt protected more than the sugar did, *e. g.*, *Mucor mirus* and *Alternaria solani*. *Trichothecium* species acted practically the same way in both salt and sugar solution suspensions. As a general rule, the suspensions in distilled water and cherry juice acted very much like those in salt solution. From the former observation, one might conclude that the salt itself was neither harmful nor beneficial to the molds, and consequently, that the sugar exerted a protective action in some cases or a destructive one in others, depending on the nature of the mold. According to Rahn[5] the effect of sugar is protective, the sugar causes a dehydration of the organism, making it more resistant. However, the heat penetration studies of Bigelow[6] lead one to believe that heat penetration might play an important part in this protective action of sugars. The fact that there was no difference between the different sugar solutions, however, presents an argument against this explanation.

5625

The Action of Carbon Filters.

S. P. KRAMER. (Introduced by J. H. Northrop.)

If one filters 100 cc. of a 1% solution of bichloride of mercury through a filter made of 5 gm. of finely divided activated carbon there is no mercury in the filtrate. If one filters through such a filter

[5] Rahn, O., *Canning Age*, August, 1928, 705.

[6] Bigelow, W. D., *et al.*, Bull. 16 L, Research Lab. Nat. Canners Assn., 1920.