MUSTY BREAD.

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MUSTINESS is not perceptible in bread until the latter is at least one day old. When the bread is new, no disagreeable taste can be detected; but on the second day, the bread becomes so nauseous as to be uneatable.

The cause of this mustiness appears to have been little, if at all, investigated; the following experiments, therefore, may be not without value.

The following preparations were made:—

- (a) Musty bread, 1 day old, soaked in water, enclosed between watch-glasses.
- (b) Flour, from which the above bread was made, similarly treated.
- (c) Sweet bread, ditto.
- (d) Musty bread, 9 days old, ditto.
- (e) Minute loaf, from good flour, in which a bit of *a* (after 10 days) was enclosed.
- (f) Thurber's snowflake flour, treated as in *b*.
- (g) " " placed in a bag in a damp cellar.

(a) In six days begins to turn yellow, has a powerful disagreeable odour. On the lower glass are white sterile flocci of *Aspergillus glaucus*. The colour gradually deepens to a brilliant orange yellow, and the bread obtains a "cheesy" consistency (looks

exactly like toasted cheese). The odour is very nauseous, something between that of *Russula foetens* and *lactic acid*. Under the microscope, the "cheesy" part is destitute of mycelium, but swarms with minute animalculæ. Some of these are rod-shaped bodies from .00005 to .0002 inch in length, endowed with active motion, which consists of a short rush, then a quivering, and a rapid rotation on the minor axis. (*Vibrio rugula*?) There are also smaller, and apparently spherical bodies, about .00002 inch in diameter, which are not quite so active, but move with a to and fro motion. (*Bacteria termo*?) The magnifying power at my disposal is not high enough to enable me to describe these organisms with greater precision. The reaction is acid to litmus. In ten days, the colour of the mass loses its brilliancy, and subsides into a dull buff. The odour has disappeared. The vibriones can be no longer seen, they are dead. The bacteria are still visible as motionless dots. A portion is inserted in a small loaf *e*.

In this experiment the growth of *A. glaucus* is feeble, the flocci never get beyond the sterile stage. This is due to the bread undergoing putrefaction, subsiding into a pulpy mass which is too damp to permit the growth of the fungus.

(The brilliant colour at first suggested the presence of *icrococcus Maurantiacus*, but I should not be able to see them with $\frac{1}{4}$ -inch objective, even if present.)

(*b*) In four days produces "forests" of *Mucor mucedo*. No further change. The flour ultimately dries up.

(*c*) In four days, sterile flocci of *A. spargillus glaucus* appear. In six days begins to smell after the manner of fungi. A bright red spot is seen (*Palmella prodigiosa*?) which presents nothing characteristic under the microscope and undergoes no further development. A green spot proves to be fertile flocci of *A. glaucus*. In seven days more green spots. Ultimately the bread becomes nearly covered with green *A. glaucus*. There is no *mucor*.

At no period does the bread become "cheesy," but gradually dries up. The odour is entirely different from that of decaying musty bread. The fungus flourishes luxuriantly.

(*d*.) In three days begins to have a nauseous odour, a few colonies *A. glaucus* (sterile) seen on edge where *least moist*. There is a slight tinge of yellow near one edge. Fourth day, the yellow spot has spread, deepened in colour and looks greenish. Another yellow spot showing, near which *M. mucedo* is growing luxuriantly.

Fifth day, the greenish yellow spot is merely change of *A. glaucus* from sterility to fertility. The yellow spot near the *M. mucedo* has spread and is turning "cheesy," but the colour is not so brilliant as in *a*, it will probably deepen with age. Under the microscope the vibriones and bacteria appear as before mentioned.

In this preparation the bread is three times the size of that in *a*, and instead of being laid horizontally in a watch glass, is placed vertically in a wine glass, consequently, the upper portions get comparatively dry and suitable for the growth of the fungi.

(*e*) On breaking open, a cavity, with yellow walls, presents itself where the portion of *a* was inserted. It is moistened and placed in a covered wine glass. The next day active bacteria are found in the yellow spot. No useful information is derived from this experiment.

(f) In seven days dries up completely, without having generated any fungoid growth whatever.

(g) In ten days begins to taste musty, sterile flocci seen. The next day the mustiness is perceptible to the sense of smell. On the 12th day, the flocci having become fertile, are seen to be those of *Mucor mucedo*.

These experiments might perhaps have been extended, but with questionable advantage. We see that ordinary bread turns mouldy, owing to the growth of *A. glaucus*. Musty bread, on the other hand, yields both *A. glaucus* and *M. mucedo*, and then undergoes putrefactive decomposition, becoming the home of vibriones and bacteria. These organisms, of course, can have nothing to do with the mustiness, they only flourish because there is a suitable nidus for their growth. We know how difficult it is to escape from the all pervading germ.

It is, however, curious that the musty bread should decay, and the sweet bread should not, whilst the only *apparent* difference between them is in the growth of *M. mucedo*. The suspected flour produces an abundant crop of *Mucor*, but does not decay. This is, no doubt, due to the fact that starch is not so suitable a nidus, as is dextrin, for bacteria.

Perfectly pure flour failed to decompose when kept between watch glasses, but when placed in a damp cellar readily became musty, and produced a crop of *M. mucedo*.

I think we may fairly conclude that this fungus is the cause of the mustiness, at least, in the two present cases; it by no means follows that it is the agent in *all* musty bread, since other species may possess similar properties.

The history of the musty bread, and flour, with which my baker supplied me, now becomes clear. The flour was stored in a damp place, causing fungoid growth. To arrest decomposition *the flour was then baked*. [This idea occurred to me on noticing that the flour was very dark (brown) in colour, exhibiting evidence of having been charred.] When the bread was baked, the assimilation of moisture regeuerated the fungus, thus causing the bread to become musty, for which result it is not necessary for the plant to arrive at maturity; the disagreeable taste is developed as soon as flocci are visible under the microscope.

The reason why the musty bread alone putrefied does not seem clear. It cannot be accidental. Granting, for the sake of argument, that a crowd of bacterial germs was "hunting round" at the particular moment when the specimens were being prepared, it is impossible to conceive that they could have located themselves in one watch-glass to the exclusion of the rest, but a few inches away! Further, no special precautions were taken for their exclusion, and the second portion of musty bread, which was at first kept apart, underwent the same changes in decomposition as did the first portion. It would appear as if the *Mucor* has a specific chemical action upon the bread, that is not possessed by *Aspergillus glaucus*.