SICK WHEAT—WHAT DO SCIENTISTS KNOW ABOUT IT?*

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The term "sick wheat" refers to a condition very well known to the grain trade and to the Federal Grain Inspection offices. This term is none too precise, however, since kernels falling into this classification are not only sick but are actually dead, at least from the standpoint of germination. The Canadian wheat grading system has no provision for this form of damage, and it is doubtful if two grain grading experts would exactly agree on a critical definition of this condition. The germ in sick wheat is usually brown to black in color, and in cases of extreme damage it is missing entirely, leaving only a blackened cavity. Some workers have thought that mold growth was the primary cause of "sick wheat" and that if mold and bacteria proliferation were inhibited the wheat would not become "sick." This belief arose because molds and bacteria have been commonly found on sick wheat, but it now appears that mold growth is only an accidental accompaniment of sick wheat and is not directly associated with this condition. There is evidence that the trouble will develop in storage at moisture contents below those necessary for mold growth.

Mold growth is the chief cause of grain deterioration and heating, and when present indicates that the grain was excessively high in moisture content at some time in its past history. Deterioration of wheat seeds can proceed to a substantial extent without a noticeably dark germ although it may appear when the temperature due to mold activity has markedly increased. One belief was that sick wheat was caused by the killing of the embryo by toxic agents produced by mold growth. The toxic character of the molds which cause respiration and heating of grain at high moisture levels is well recognized. This killing of the embryo is not necessarily associated with the formation of a dark germ.

Sick wheat has been attributed to weathering of grain in fields, storage in deep bins, crusting over of grain surfaces in bins, smothering of the grain by lack of air, bacterial growth, etc. There is little support for these beliefs in experimental data. Studies by the United States Department of Agriculture indicated that sick wheat could be produced in grain containing 12.2% moisture by storage at 104° F. for one year. No mold growth would be expected at this moisture content. Usually the onset of the condition was paralleled by an increase in the acidity of the fat extracted from the wheat, as well as by a decrease in seed germination.

A more recent investigation conducted at the University of Minnesota proved that samples that graded sick had at some period in their history possessed a moisture content sufficiently high to

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cause mold growth of the type generally responsible for storage and heating damage. A study under controlled conditions employing atmospheres of carbon dioxide, nitrogen and oxygen over the grain showed that wheat containing 12.1% moisture stored over a five month period at room temperature exhibited no marked changes in germination, fat acidity or free sugar formation. No evidence of sick wheat was found. When, however, the moisture content was raised to 18.0% fat acidity increased for all the samples, and mold growth was evident in the sample stored under an atmosphere of oxygen. Sick wheat was present in all these samples after one month's storage, and the proportion of kernels affected increased rapidly with time of storage until after four months 100% of all samples were affected irrespective of the storage atmosphere.

Flour milled from these samples showed no abnormalities for the 12.1% moisture content samples. It is quite remarkable that wheat stored under carbon dioxide and nitrogen showed no deterioration, despite the popular idea that grain must "breathe" to be able to maintain viability and commercial quality. For similar wheat stored at 18.0% moisture the fat acidity was greatly increased in the feed portions except in the bran. In the patent flour fat acidity was only slightly higher than in normal wheat flour. Under an oxygen atmosphere, however, the fat acidity in the low grade flours was 300% above that of the bran fraction, and almost 600% higher than the corresponding value for normal wheat flour.

Evidently the basis of the changes in fat acidity in atmospheres of carbon dioxide and nitrogen lies in the lipolytic enzymes associated with the tissues of the aleurone and scutellum, since low grade flour contains the major portion of this material. In the presence of oxygen, however, molds make their appearance and greatly increase the fat acidity. This fact appears to be the chief result of mold action on grain.

The cause of the dark color of sick wheat has not been explained. It may be due to chemical interaction of sugars with proteins, which is known to cause darkening in foods such as dried fruits and eggs.

The only remedy for sick wheat lies in preventing its inception by storing grain after harvest under dry and cool conditions, with frequent turning. It is suggested that a better term than "sick wheat" be applied to grain suffering from the malady described, possibly "germ-damaged" or "germ-darkened." As one cereal chemist recently stated, "This wheat is not 'sick,' it is **dead!**"