Temperature Effects During the Storage of Cottonseed

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Abstract

A recently published formula (1) enables persons storing cottonseed to predict the amount of deterioration to be expected as a function of storage time. It permits expected storage losses to be weighed against other economic alternatives such as accelerated processing. However, the formula has a serious limitation inasmuch as it is useful only when the storage temperature remains constant. This paper discusses the effect of temperature upon the seed deterioration rate and it extends the formula to cover the effect of changing temperature conditions.

Introduction

It is well known that cottonseed will deteriorate during storage and that severe economic losses can occur if storage conditions are not controlled. The storage of cottonseed has been studied extensively (2). Storage at high moisture contents or at high temperatures promotes the formation of free fatty acids. Pigmentation also increases and this causes the oil produced to be inferior.

The free fatty acid rise during storage will vary according to a number of parameters. Some of these are time, temperature, degree of infection with microorganisms and moisture content. There may be others that are not recognized. At the present it is impossible to predict storage performance by measuring and evaluating each storage parameter and then projecting their cummulative effect. Harris and Wamble (1) found, however, that the long term rise in free fatty acid can be predicted on the basis of the rise over a comparatively short time, provided the storage parameters are unchanged. Only two free fatty acid determinations are needed, one at time T1 and the other at time T2. These are then inserted in the formula $(T2/T1) = (FFA2/FFA1)^K$ and the value of K is calculated. With K a known value, the expected free fatty acid analysis FFA3, T3, can be readily obtained at any selected time. K, then, is a numerical representation of the storability of the seed. Not only is it useful for predicting future storage performance but it permits the storability of different lots of seed to be compared. When this is done, the initial free fatty acid contents must also be considered. A convenient comparison can be made by computing and comparing the times necessary for a specified rise in free fatty acid content to occur, for example 1%.

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Results and Discussion

One reason that the effect of storage temperature upon storage performance has been discussed in the literature in general terms is that it is difficult to isolate its effect from that of the other parameters involved. This problem was lessened by the discovery that storage performance could be characterized by a K value. It was reasoned that if a relationship could be established between a change in storage temperature and the resultant change in K value, corrections for temperature changes could be made.

Since most cottonseed oil mills monitor their storage units regularly, a large amount of data was available. Records from eleven mills covering three seasons were obtained (Private communication, Coleman & Verdery, Anderson, Clayton & Co.). Standard statistical techniques were then used to calculate the mean performance values given in Figures 3 and 4. Each of these Figures shows the fatty acid rise that occurred for seed having initial free fatty acid values of 0.5%, 1.0% and 2.0%. Figure 3 is for 12% moisture seed; Figure 4 is for 9% moisture seed.

The effect of temperature change on the K value is shown on Figures 1 and 2. A slight curve best

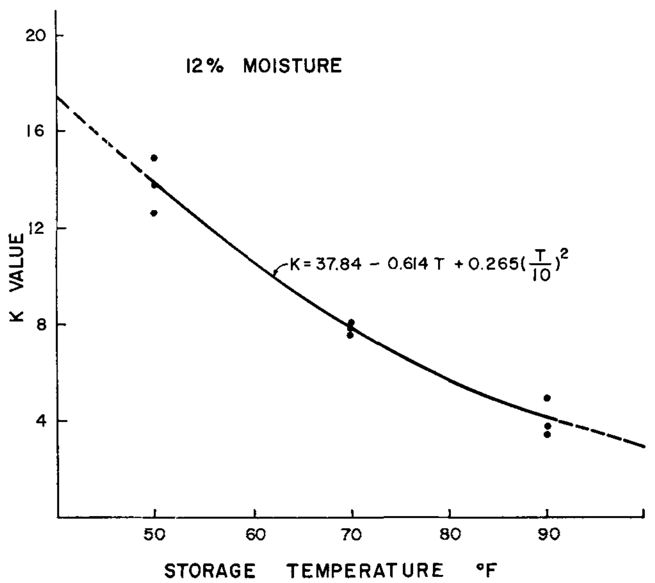

FIG. 1. Free fatty acid rise in 12% moisture cottonseed meats stored at different temperatures.

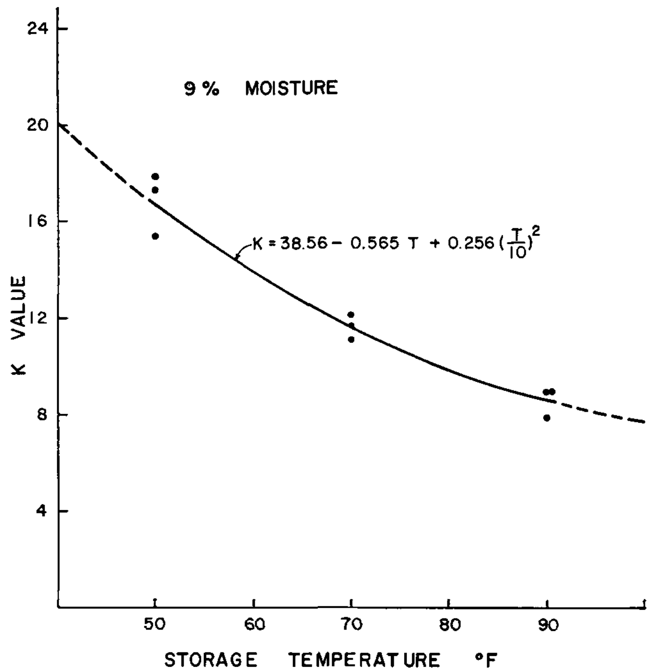

FIG. 2.

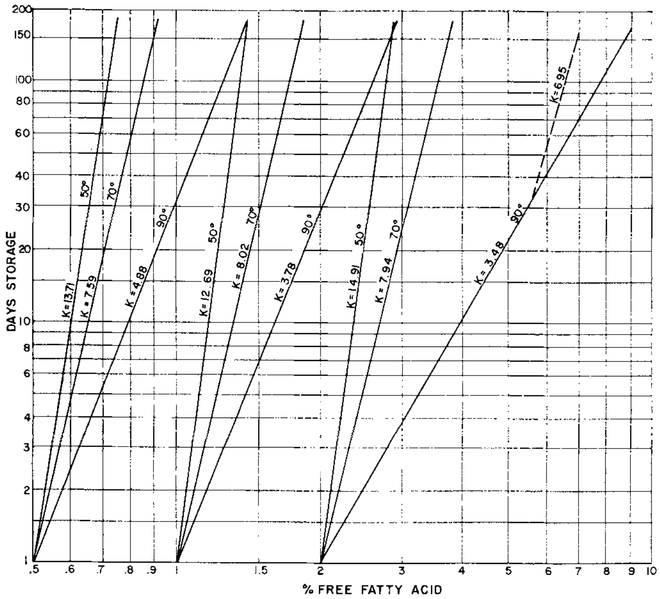

FIG. 3.

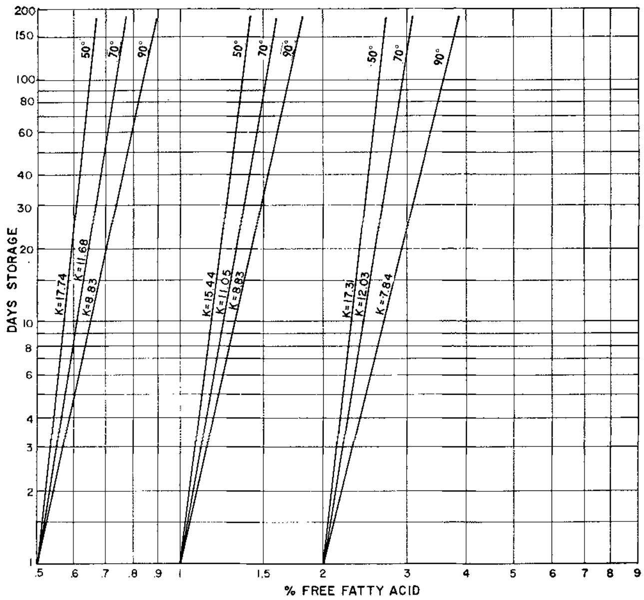

FIG. 4.

fits the data. Equations that fit the curves are shown on each Figure. The equations indicate nearly the same curvature and each set of data can be represented reasonably well by using the average curvature. The following formula can then be derived from this average: $K2 = K1 + 0.591\ (T1 - T2) - 0.261\ [(T1/10)^2 - (T2/10)^2]$. (K1 is measured K value at T1 temp; K2 is estimated K value at new temperature.)

If seed has been stored under uniform conditions long enough to measure the K value, then the effects of a change in the storage temperature can be estimated by the above formula; for example, if the 90 F –12% moisture –2% initial free fatty acid seed of Figure 3 were cooled to 70 F after one month and held at 70 F for the remaining five months, the K value would change from 3.48 to 6.95 $[K = 3.48 + 0.591\ (90\text{–}70) - 0.261\ [(90/10)^2 - (70/10)^2]]$. In this case the final free fatty acid content would be 7% rather than 9%. This is shown by the dotted line on Figure 3. It should not be too difficult for an Oil Mill Superintendent to determine whether a 2% reduction in fatty acid would justify the expense of additional cooling.

A word of caution is in order. The procedure given above for predicting temperature effects is based upon mean or averaged values for many storage situations. The effects of other parameters were eliminated by statistical techniques (they tended to average out). In any particular situation, the results obtained may or may not follow the predicted course. Nevertheless, the basic principle is sound and judgements concerning the effect of changing storage temperature should also be sound to the extent that other factors remain constant.

REFERENCES

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