Germination and Free Fatty Acids in Seed Stock Lots of Cottonseed

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ASIDE from the natural sterility, low germination of cottonseed is attributed to deterioration of the seed after maturity. One index of deterioration is the amount of free fatty acid present as a result of the splitting of the oil into glycerine and the component fatty acids. It was shown in a previous publication (2) that, for all practical purposes, individual kernels containing more than 1% of free fatty acids will not germinate. It was also observed for the seed examined that about 5% of the kernels containing less than 1% of free fatty acids did not germinate. This amount in the kernel is equivalent to approximately 3% in the extractable oil.

It has been noted that cottonseed exposed to wet weather in the field are likely to be lower in viability and to contain higher percentages of free fatty acids than those harvested without being subjected to unfavorable exposure (3, 4). Similar observations have been made on cottonseed stored under conditions of high moisture and/or temperature (4).

In order to ascertain whether the percentage of free fatty acids in the extracted oil may be used as an index of the percentage of germination of bulk lots of cottonseed reserved for seeding, 254 samples were selected from lots of seed tested for germination by the Seed Laboratory of the Arkansas State Plant Board, using either the sand or the towel test. These samples were analyzed for percentage of free fatty acids in the extracted oil by the Southern Regional Research Laboratory, using Official Method Aa 6-38 of the American Oil Chemists' Society (1).

The samples tested included seed of the following varieties: Arkot 2-1, Coker Wilds, Coker 100 W. R., D and PL No. 14, D and PL No. 15, Delfos, Deltapine No. 78, Dortch's No. 1, Dortch's Improved Rowden, Empire, Half and Half, Paula, Rowden 41B, Stoneville 2B, and several unknowns. They varied in germination from 13% to 96% and in free fatty acid in the oil from 0.52% to 8.13%.

The samples were ranked in increasing order of percentage of free fatty acids in the oil and divided into sub-groups by selecting intervals of percentage of free fatty acids of sufficient magnitude to contain a significant number of samples. The data, thus summarized, are given in Table I. The variations in the percentage of free fatty acids in the oil depend on the number of kernels in which the free fatty acids occur and on the amount of free fatty acids in the individual kernels. As has been shown previously (2), the percentage of free fatty acids in a kernel may be many times the amount that is associated with loss of viability or ability to germinate. For these reasons the data could not be treated adequately by correlation and was interpreted on the basis of probability.

ON the basis of averages, there is a marked decrease in germination with an increase in percentage of free fatty acids in the oil. Considerable variation in the percentage germination is noted for each sub-group. Should the sub-groups have been selected on the basis of germination, a similar variation in percentage of free fatty acids would have been observed in each.

For each sub-group the proportion of samples having germination values of at least 70% were calculated to obtain the probability of germination above the 70% level. The probability values for the 80%, 85%, and 90% minimum germination levels were calculated similarly. The results are included in Table I.

It is apparent that the probability of obtaining a specified minimum level of germination drops rapidly as the percentage of free fatty acids increases. For example, the chances are about 3 in 4 that a lot of seed having a free fatty acid content in the oil of from 0.50% to 0.74% will have at least 80% germination. The probability of germination at this level of all the samples examined was 0.45.

Thus it seems practical to use the percentage of free fatty acids as a preliminary or screening index whenever possible in reserving cottonseed for seeding purposes with subsequent use of the germination test for confirmation. Such a practice would appear to increase the probability that the lots reserved would have a specified minimum germination value. As seed with high moisture contents increase in free fatty acid

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[2] In cooperation with the Production and Marketing Administration, U. S. Department of Agriculture, under Marketing Act of 1946.

TABLE I

Summary of Free Fatty Acid in Oil Values and Percentage of Germination of Cottonseed Samples

Range of F.F.A. for Sub-groups	No. of Samples	Average F.F.A.	Average Germination	Range of Germination	Probability of Germination Above Specified Level			
					70%	80%	85%	90%
%		%	%	%				
0.50-0.74	17	0.67	84	68-94	0.94	0.76	0.59	0.18
0.75-0.99	46	0.89	81	35-96	0.83	0.72	0.48	0.19
1.00-1.24	53	1.12	79	56-94	0.87	0.60	0.25	0.08
1.25-1.49	33	1.38	79	65-90	0.88	0.58	0.33	0.03
1.50-1.99	39	1.72	75	32-88	0.74	0.36	0.18	0
2.00-2.99	31	2.38	72	55-93	0.68	0.23	0.10	0.03
3.00-4.49	18	3.65	62	38-82	0.22	0.06	0	0
Above 4.50	17	6.24	49	13-63	0	0	0	0
All samples	254	1.85	74	13-96	0.69	0.45	0.25	0.07

content and decrease in percentage germination (4) on storage, the moisture content of cottonseed reserved for seeding purposes should be considered also and be low enough to insure good preservation.

Summary

The relationship of the free fatty acid content in the oil to the percentage germination for 254 samples of cottonseed of different varieties indicates that the free fatty acid content may be used as a practical screening index for use in selecting lots of cottonseed to be reserved for seeding purposes and subsequent testing for germination. The percentage germination decreases in general with increasing free fatty acid content. The mathematical probability that a given lot of seed will exceed a specified minimum germination value decreases markedly as the free fatty acid content of the oil increases. Insofar as practical, it is suggested that cottonseed reserved for seeding have a low free fatty acid content, less than 0.75% in the oil if at all possible.

Acknowledgments

The authors wish to acknowledge with thanks the assistance of Claire Lesslie and Lloyd G. Burkenstock Jr. in determining the free fatty acid values.

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[Received July 25, 1950]

A Colorimetric Method for Water-Soluble Silicates in Detergents[1]

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THIS method grew out of the need for a rapid, fairly accurate control method to make occasional determinations for silica on the crutcher mix and the finished soap products. The method worked so well that it was expanded to cover the analysis of all types of detergents, even those highly built with phosphates. If the assumption may be made that water-soluble silica is the same as the total silica, the method is just as accurate as the dehydration method. When an appreciable amount of water-insoluble silicate is present, the method may be modified to include a determination of this material. When only a roughly accurate control is required, the amount of silica that is water-insoluble may generally be ignored.

Discussion

The method is based on the development of the yellow silico-molybdic acid complex. Although some workers (4) have suggested that the reduction to the blue complex affords better detection of smaller quantities of SiO_2 (in the range of a few p.p.m.), it was felt that the range of concentrations to be encountered as applied to detergents did not warrant the use of this modification. Moreover the interference of phosphorus is greater and more difficult to eliminate when the blue color is developed.

Citric acid was found to be an excellent bleach for the yellow phospho-molybdic acid color, having no effect on the color produced by silica. Knudson (3) first precipitates the phosphates with calcium chloride but shows that the pH at this point is quite critical and requires a buffer to keep the pH of the solution at 10.0 before precipitation.

Figure 1 is a curve showing the development of the color from silica alone while Figure 2 shows the additional effect of phosphorus followed by the addition of citric acid. It was found that the amount of citric acid prescribed by the method would completely eliminate the effect of 25 times as much P_2O_5 as SiO_2. Table I indicates that the proposed method is as good as the dehydration method and a series of duplicate analyses show the standard deviation to be $\pm$ 0.05% for samples containing 1.5 — 5% SiO_2 and $\pm$ 0.01% for samples containing up to 1.5%.

Apparatus

1. Klett-Summerson colorimeter.
2. No. 42 Klett-Summerson filter.
3. 2 x 4 cm. absorption cells.
4. Burettes, pipettes, volumetric flasks, etc.

Reagents

1. Neutral, 95% 3A or No. 30 alcohol.
2. Ammonium molybdate solution. 10% $(NH_4)_6Mo_7O_{24}\cdot H_2O$ in water.
3. Citric acid solution. 10% $C_6H_8O_7\cdot H_2O$ in water. Small quantities should be prepared so that the solution being used is not more than a week old. What little mold forms within this time should be filtered off before the reagent is used.
4. Sulfuric acid. 1:4 in water.
5. Standard silica solution (1 ml. = 0.0002 gm. SiO_2). Fuse 0.2000 gm. of pure SiO_2 in 2 gms. of Na_2CO_3 — K_2CO_3 fusion mixture for about 15 minutes. Cool and dissolve in warm water, using a platinum dish for a container. Cool the solution and transfer to a 1,000-ml. volumetric flask. Make to volume without delay and store in a wax lined or hard rubber bottle.

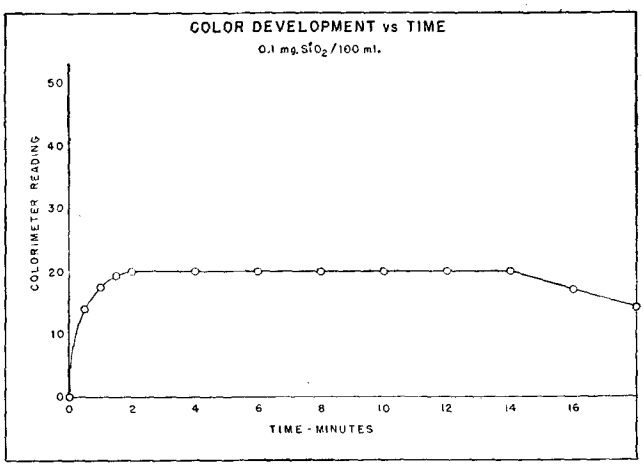

FIG. 1.

[1] Presented at the fall meeting, American Oil Chemists' Society, Oct. 31-Nov. 2, 1949, Chicago, Ill.