Note on the Hygroscopic Equilibrium of Cottonseed and Cottonseed Products

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IN a previous publication (1) the hygroscopic equilibrium of whole cottonseed, cottonseed kernels, and undelintered hulls was investigated over the relative humidity range of 31 to 93%. Since the publication of the previous article the investigation of hygroscopic equilibrium of cottonseed and its products has been extended to include whole seed, delintered seed, kernels, linters, and lint-free hulls over the moisture range of 11 to 93% with the results reported below.

Materials and Methods

The procedure used to obtain the desired relative atmospheric humidity in contact with the seed and derived products was the same as that previously described (1). The salts used in the preparation of the required saturated solutions and their relative humidities (2) at 25°C. are listed in Table 1.

The cottonseed used in this investigation was Stoneville 2B Variety grown at the Delta Branch of the Mississippi Agricultural Experiment Station, Stoneville, Mississippi, in 1946. The seed as received contained 8.9% moisture. Analysis of the seed calculated to a moisture-free basis gave nitrogen 2.97%, free fatty acids 0.63%, lipids 22.28%, and ash 4.14%.

TABLE 1

Relative Humidity of Atmosphere in Contact With Saturated Solutions of Various Salts at 25°C.

Salt	Relative humidity, per cent
Lithium chloride	11.1
Potassium acetate	22.5
Magnesium chloride hexahydrate	32.5
Potassium carbonate	43.7
Sodium dichromate dihydrate	53.3
Sodium nitrite	64.4
Sodium chloride	75.4
Potassium chromate	86.4
Ammonium dihydrogen phosphate	92.5

Experimental

A large sample of whole cottonseed was delintered in a laboratory-model delintering machine. A 537.4-gram sample of whole seed yielded 65.1 g. or 12.1% of linters containing a very small amount of hull bran or pepper and 475.3 g. of delintered seed. A portion of the delintered seed was separated into kernels and lint-free hulls. Samples of whole seed, delintered seed, linters, kernels, and lint-free hulls were stored for 30 days at 25°C. in humidifying chambers consisting of large desiccators containing partitioned wire mats suspended over mixtures of saturated salt solutions and solid salts. At the end of the storage period duplicate portions of these samples were transferred to moisture dishes and weighed immediately, after which they were dried at 103°C. for 16 hours in a forced-draft oven, reweighed, and the loss in moisture calculated.

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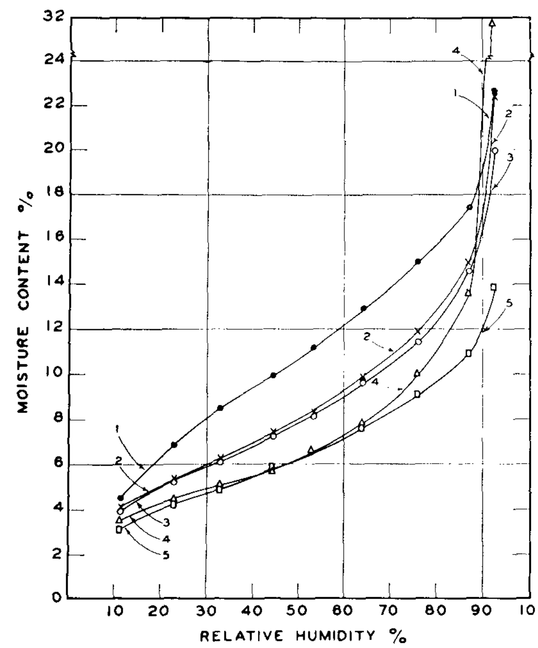

FIG. 1. Equilibrium moisture contents at various relative humidities of (1) lint-free hulls, (2) delintered seed, (3) whole seed, (4) kernels, and (5) linters.

In order to determine the distribution of moisture between kernels and lint-free hulls a 10-gram sample of delintered seed was separated by hand into kernels and lint-free hulls. All of the kernels obtained from this sample were placed in one moisture dish, and all of the lint-free hulls were placed in a second moisture dish and the two products were stored in a humidifying chamber for 30 days at 25°C., after which they were removed and their moisture contents determined. Similar experiments were performed in duplicate for each of the selected relative humidities.

TABLE 2

Percentage of Moisture in Cottonseed and Derived Products in Equilibrium With Air of Various Relative Humidities

Relative humidity, per cent	Whole seed	Delintered seed	Linters	Kernels	Lint-free hulls
11.1	3.9	4.05	3.1	3.45	4.5
22.5	5.25	5.3	4.2	4.4	6.9
32.5	6.1	6.25	4.9	5.0	8.5
43.7	7.25	7.4	5.8	5.7	9.95
53.3	8.2	8.3	6.4	6.55	11.2
64.4	9.6	9.9	7.6	7.8	12.95
75.4	11.4	11.9	9.1	10.0	15.05
86.4	14.55	15.0	10.9	13.65	17.45
92.5	20.0	22.45	13.9	31.77 [a]	22.7

[a] Sample moldy at end of experiment.

Results

The equilibrium moisture contents of the intact cottonseed, delintered seed, linters, kernels, and lint-free hulls stored at various relative humidities are given in Table 2 and graphically in Figure 1.

The equilibrium moisture content of the delintered seed was found to be only slightly higher than that of the whole seed. The linters had the lowest equilibrium moisture content of the various cottonseed products. Since the linters comprise only about 12% of the total weight of the seed, the hygroscopic equilibrium of this component contributes only a small fraction to the total hygroscopic equilibrium, *i.e.*, the whole seed and delintered seed have similar hygroscopic equilibria.

The results of the determinations of the distribution of moisture between kernels and lint-free hulls showed that the kernels constituted 63 to 64.5% of the weight of the delintered seed in equilibrium with air having a relative humidity ranging from 11 to 86%. Throughout this humidity range the ratio of the wet weights of the kernels to the wet weights of the lint-free hulls remained constant.

Summary and Conclusions

The hygroscopic equilibrium of a sample of the Stoneville 2B variety of cottonseed and its derived products has been determined over the relative humidity range of 11 to 93%. In a previous publication (1) the hygroscopic equilibrium of a sample of the D and PL variety of cottonseed was determined over the range of 31 to 93% relative humidity. Comparison of the previous and present results show that the whole seed and kernels of both varieties exhibit the same hygroscopic equilibrium behavior. A comparison of the aforementioned results with those reported by Simpson (3) on Stoneville 2B variety, and by Franco (4) on the 1A 7387 variety grown in São Paulo, Brazil, show that for intact cottonseed the hygroscopic equilibrium behavior is the same.

On the basis of the curves given in Figure 1 and on the assumption that the cottonseed used was representative of cottonseed in general, it is possible to calculate the equilibrium moisture content of the whole cottonseed or any component thereof. For example, cottonseed consisting of 12.1% linters, 87.9% delintered seed, 56.0% kernels, and 31.9% lint-free hulls, and containing 12% moisture on a whole seed basis, will yield linters, delintered seed, kernels, and lint-free hulls having 9.4, 12.7, 10.8, and 15.4% moisture, respectively.

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Studies on Olive Oil Standardization

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THE world's production of fats and oils, which before World War I (1914) was around 15 million tons, has now increased to 26 million tons. Since 1914 other changes also have occurred in the relative proportion of the world production of the various oils. Oils and fats from animal origin which previously represented more than two-thirds of the total amount now represent less than half. Of the plant origin fatty substances the greatest part (about three-fourths) are produced by yearly plants, mainly cotton seed, peanut, linseed, soya bean, and sunflower; the other one-fourth is derived from trees (olive, cocos, Elaeis, and others). Although olive oil production has been increased by 30% since 1914, the rate of increase of the other tree oils was much greater (almost tripled) during the same period. The reason for this increase is the lower cost of production due to the higher yield and the lower living standards in the tropics and Africa where these oils are mainly produced. The production of olive oil is practically limited to the Mediterranean countries and to California. The importance of olive oil however is not based only on the size of the world production of it but also on its superior quality and flavor. Olive oil, when well prepared, is highly appreciated as salad oil and usually is added in small proportions to other oils (refined seed oils) in order to impart to them a good flavor. This is the reason why extensive research work on olive oil is being conducted in almost every Mediterranean country as well as in California. Peanut and soya oils are produced in Asia and the main source of cotton seed oil is the United States. Of the plant oils, about one-third is used for industrial purposes (soap, etc.). The industrial use of plant oils is decreasing steadily because of the development of better methods of refining which permit a larger proportion of crude oil to be used for human consumption. Another factor is the increasing production of synthetic oils for industrial purposes. More than 50,000 tons of synthetic oils were produced in 1938 in Germany. Besides the synthetic process a biological process for fat production has been studied in Europe lately. This last method is based upon the culture of various microorganisms (Penicillum Zavanicum, Aspergillus niger, and others) on a medium containing carbohydrates and inorganic salts. Of the animal fats, fish oil (mainly whale oil) production received a new impetus due to the introduction by Germans and Japanese of better fishing methods. Asia and Africa supplied about 70% of all export of fats. United Kingdom, Germany, France, and the United States absorbed almost 90% of all imports. The production of butter before the last war was around four millions tons. Europe produced 48% but consumed more than 60%. Margarine, which was considered previously as an animal fat, is now made from hydrogenated plant oils to a proportion of 94% or more. Peanut butter, a fat which also contains proteins and carbohydrates, is produced almost exclusively in the United States. The consumption of fats and oils in the world varies greatly. Among the states with the highest consumption (before the war) were Denmark and Scandinavian countries with annual consumption of more than 28 kilos per capita, Great Britain, United States,* and Germany with 24

* Invisible fats not included.