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THE OIL:GOSSYPOL RATIO OF COTTONSEEDS AND ITS POSSIBLE EFFECT ON THE REFINING LOSS OF CRUDE COTTONSEED OIL*

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The gossypol content of crude cottonseed oil is dependent upon two factors: (1) the amount of gossypol in the seeds from which the oil is expressed and, (2) the condition under which the seeds are heated at the oil-mill previous to pressing out the oil. Heating the moist seeds for long periods destroys gossypol and alters its solubility such that only a small amount finds its way into the crude oil.[1]

Royce and Lindsey[2] have shown that the alkali refining loss of certain grades of crude cottonseed oil may be reduced 1 to 3 per cent by the addition of fractional percentage amounts of gossypol. This property of gossypol which produces a good break in the refining process, is attributed to the reaction of gossypol with naturally occurring protein degradation products which act as emulsifying agents. It might be reasoned therefore that crude oil of high gossypol content will have a lower refining loss than oil of low gossypol content.

Determinations have been made of the gossypol and oil content of cottonseeds (Oklahoma Triumph 44 Variety) produced under different fertilizer treatments in various sections of Oklahoma during three years. The results are shown in Table I.

Since the cotton plant blooms over an extended period of time samples of mature seeds from an entire plant will include some seeds that developed early and others that developed late in the season. Cottonseeds as they are received at the oil-mill will include these early and late matured seeds and a certain amount of seed which, due to drought or other adverse growing conditions, is undeveloped and immature. To determine whether or not the gossypol and oil content varied with time of development, collections of seed were made from early developed bolls by selecting fully matured bolls which were close to the main stem and near the base of the plant; those which formed at the end of the branches and near the top of the plant were taken as representing late development. To obtain equally representative samples the same number of bolls, usually 4 or 5, were taken from the top of the plant as were taken from the bottom.

The effect of under nutrition on the development of gossypol and oil in the seed was determined by selecting bolls from poorly developed plants growing in parts of the field subject to considerable erosion and where vegetative growth had been markedly retarded. These were obtained the first two years from test plots on and adjacent to the experiment station farm and in the last year from similar plots located a few miles

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distant. The seeds from approximately 100 bolls formed a composite sample.

RESULTS AND DISCUSSION

During two consecutive years the seeds produced in McIntosh County contained larger quantities of gossypol than seeds from similarly fertilized plots in the other localities considered. Furthermore, the seeds produced on the unfertilized check plots in McIntosh County contained more gossypol than seeds from fertilized plots in the other localities with but one exception, that being Greer County, second year, complete fertilizer plot.

The influence of locality on the composition of the seed is also brought out in the results of the oil determinations. With the exception of the seeds produced on one of the check plots in Bryan county during the first year, none showed as high an oil content as those produced on the six different plots in McIntosh County during the two years considered. From Table I it may be readily discerned that if the seeds are arranged by counties in order of increasing oil content they take the same relative position as when listed in order of increasing gossypol content for the two years considered. This fact emphasizes the relationship between oil and gossypol content.

A consideration of the effect of fertilizers on the composition of the seeds shows that during three years, the application of a complete fertilizer tended to raise the gossypol content of the seeds in all localities. It was particularly effective in the case of seeds produced in Greer County in the first two years and resulted in an appreciable lowering of the gossypol content in only one instance (Payne County, second year). The oil content of the seeds was likewise increased by this treatment in 7 of the 10 cases.

The addition of either nitrogen or phosphorus generally resulted in a decrease of gossypol and in only 3 of the 16 cases produced an appreciable increase. Likewise, the oil content was decreased more often than it was increased by the addition of either of these fertilizer constituents. Nitrogen when used alone, decreased the oil content of the seeds in 6 of the 7 cases cited. A combination of nitrogen and phosphorus decreased the gossypol content in all but one instance (Bryan County, second year) and in that case the resulting increase was so small as to be negligible. The effect of this combination of fertilizers on the oil content was variable.

The increased gossypol and oil content of seeds produced on the complete fertilizer plots suggests that potassium is an influencing factor; or possibly that certain fertilizer ratios are more favorable to gossypol and oil development than are others.

Table II reveals no consistent differences between the gossypol content of seeds from bolls that developed early and those from bolls that developed late in the season. There are indications of a decreased oil content in seeds from late developing bolls, but this difference is small and may be of no real significance.

The seeds from poorly developed plants contained approximately the same percentage of oil as those from normally developed plants; in fact, the oil percentages approach those which might be expected of composite samples of seeds taken from the entire field. Unlike the oil content, the percentage gossypol content was decreased slightly in the seeds from the poorly developed plants. The result might be anticipated from the fact that the formation of oil takes place early in the development of the seed and reaches completion previous to that of gossypol.[3]

TABLE I. *Relation of Fertilizer to the Percentage Gossypol and Oil Content of Cotton Seeds Based on the Dry Weight of the Delinted Seed.*

PERCENTAGE GOSSYPOL

County of Growth of the Seed	Fertilizer Addition: Nitrogen	Phosphorus	Nitrogen and Phosphorus	Nitrogen Phosphorus and Potassium	Check	Check
First Year						
Greer	0.552	0.515	0.571	0.638	0.592	0.531
Payne	.....	0.524	.....	0.578	0.560	0.538
Bryan	0.503	0.538	0.577	0.626	0.642	0.611
McIntosh	0.756	0.728	0.744	0.738	0.762	0.735
Second Year						
Greer	.....	0.690	.....	0.714	0.658	0.685
Payne	0.512	.....	0.530	0.533	0.583	0.564
Bryan	0.465	0.441	0.442	0.478	0.438	0.437
McIntosh	0.687	0.714	0.638	0.777	0.708	0.707
Third Year						
Greer	0.350	0.366	0.364	0.391	0.355	0.408
Payne	.....	0.430	.....	0.414	0.314	.....
		Percentage Oil				
First Year						
Greer	24.30	23.86	25.00	25.02	25.73	25.20
Payne	.....	24.79	.....	25.32	25.10	24.91
Bryan	26.98	26.77	27.45	27.16	28.45	27.78
McIntosh	27.96	28.79	27.74	28.23	28.65	28.14
Second Year						
Greer	.....	25.76	.....	27.05	25.96	25.90
Payne	24.10	.....	24.40	24.60	24.24	23.83
Bryan	23.17	23.13	24.92	24.37	23.82	23.52
McIntosh	27.03	28.23	27.00	28.70	27.10	27.75
Third Year						
Greer	23.19	23.55	24.30	24.39	22.86	24.49
Payne	.....	24.06	.....	24.32	23.69	.....

TABLE II. *Percentage of Gossypol and Oil (On Dry Delinted Basis) of Cotton Seeds Collected During Three Years from Early and Late Developing Bolls and from Bolls of Poorly Developed Plants.*

Source of Seeds	First Year Gossypol	First Year Oil	Second Year Gossypol	Second Year Oil	Third Year Gossypol	Third Year Oil
Early developed bolls	0.632	24.30	0.518	23.86	0.443	23.89
Late developed bolls	0.542	23.69	0.508	23.88	0.498	22.69
Bolls of poorly developed plants	0.535	24.27	0.458	23.60	0.407	23.12

OIL:GOSSYPOL RATIO

In the present study the average ratio of oil to gossypol shown by the seeds of low oil content was approximately 55:1. The seeds of high oil content had a ratio of approximately 35:1. When a similar calculation

is applied to the results of Schwartze and Alsberg[4] even wider differences in these ratios are revealed. During the years 1918, 1917, and 1919, the percentages of oil in the meats of cottonseeds of Trice variety produced in Bells, Tennessee, were 28.37, 32.51, and 35.85, respectively. The oil:gossypol ratio of the meats which had the lowest oil content was approximately 70:1 as compared to 31:1 for the meats of the highest oil content. In view of Royce and Lindsey's[2] results it seems reasonable to assume that other factors being equally influential, seeds of high oil content will by virtue of their higher gossypol content yield oil with a lower refining loss than will seeds of low oil content.

REFERENCES

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