

TEXAS AGRICULTURAL EXPERIMENT STATIONS

BULLETIN NO. 155

JANUARY, 1913

DIVISION OF CHEMISTRY

TECHNICAL BULLETIN

THE ETHER EXTRACT AND THE CHLORO-
FORM EXTRACT OF SOILS

BY

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POSTOFFICE

COLLEGE STATION, BRAZOS COUNTY, TEXAS

VON BOECKMANN-JONES CO., PRINTERS
AUSTIN, TEXAS
1913

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THE ETHER EXTRACT AND THE CHLOROFORM EXTRACT OF SOILS.

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The soil may contain any of the substances which are found in plants or animals. The permanence of the compound will depend upon its resistance to decay. In the chemical analysis of a soil it is therefore permissible to make an examination for all different classes of compounds found in the plant. Members of the Bureau of Soils of the U. S. Department of Agriculture claim to have isolated from the soil a number of definite chemical compounds, among which are certain substances which are soluble in ether, such as di-hydroxystearic acid.

Schreiner and Shorey (Bureau of Soils Bulletin 53, page 41), digested soils with alcohol and extracted the product with ether; a portion of the alcohol extract is soluble in cold ether. Our experience has shown that the wax-like substances of plants are very difficultly soluble in cold ether, and more readily in hot ether. From the alcohol extracts of soils Schreiner and Shorey claim to have isolated wax-like bodies which they designated agroceric acid and agrosterol. They state that the latter product can be obtained by extracting the saponified alcohol extract with ether. From the alcohol extract, made directly, or from the humus extracted from soils with alkali, Schreiner and Shorey (Bulletin 74, Bureau of Soils), claim to have isolated the following:

Hentriacontane
Paraffin acid
Resin acids and esters
Phytosterol

and some other substances which are soluble in ether or chloroform.

We have been unable to find any estimation of the quantity of the ether extract in soils.

METHOD OF ANALYSIS.

One hundred and fifty grams of soil were weighed into a C. S. & S. extraction capsule and extracted for sixteen hours in a soxhlet apparatus with ether. The ether had been purified over sodium and redistilled. The condenser was ground in and the receiving flask was connected to the extractor by means of a mercury seal. After the extraction was completed, the ether was evaporated off, and the ether extract dried and weighed. The soil was next extracted in the same way with redistilled chloroform, and the chloroform extract likewise dried and weighed. The products of the extraction in most cases were light yellow substances, very nearly solid. In some cases the ether extract showed a tendency to crystallize.

RESULTS.

The results of the analysis of 28 samples of soil for ether extract and of 24 for chloroform extract, are given in Table 1. With one exception, all of these soils contained over .1 per cent. nitrogen. The average percentage of ether extract in the 28 soils is 0.023 and of chloroform extract is .0174 per cent. It was not possible to trace any relation between the fertility of the soil and the quantity of ether extract or chloroform extract. Two of these soils, No. 1131 and No. 4544, were each said to produce more than a bale of cotton to the acre, and they both contain 50 per cent. more extract than the other soils. The samples examined from Brazoria county, Orange county, Liberty county, Grimes county and Jefferson county, contained more than the average quantity of ether extract. There is more precipitation in these counties than in some of the other parts of the State represented. However, we do not undertake to draw any conclusions from this fact.

Table 1—Ether and Chloroform Extracts in Percentage of Soils.

Lab. No.	Description and Origin of Soils.	Ether Extract per cent.	Chloroform Extract per cent.	Nitrogen per cent.
1209	Surface soil, "adobe," Welfare.....	.020	.024	.13
1259	Black waxy rice soil, Angleton.....	.037	.033	.15
1267	Rice soil, Raywood.....	.027	.029	.14
1279	Black sandy surface soil, Crystal City.....	.017	.030	.15
110	Houston black clay, Austin.....	.010	.011	.12
124	Sharkey clay, Paris.....	.018	.010	.23
142	Rice soil, virgin, Orange.....	.024	.048	.13
829	Houston loam, Caspir.....	.020	.011	.13
114	Travis gravelley loam, Austin.....	.011	.005	.13
330	Crawford stony clay, San Marcos.....	.017	.009	.31
845	Sanders silt loam, Robertson County.....	.027	.013	.18
1131	Wabash clay, Hagenport.....	.032	.022	.28
3363	Houston Black clay, Lexington.....	.015	.011	.12
3620	Surface soil near San Marcos river.....	.015	.009	.12
3662	Orangeburg clay Lexington.....	.019	.018	.13
4344	Surface soil good, Osceola.....	.024	.008	.11
3357	Surface soil good, Benbrook.....	.017	.017	.15
3399	Surface soil, Bonham.....	.016	.023	.12
3427	Subsoil from Red River.....	.011	.006	.10
3613	Surface soil, Olmito.....	.018	.017	.28
4544	"Elm bottom land," Bedias.....	.030	.010	.11
4565	Black waxy soil, Waco.....	.012	.008	.15
4605	Very poor rice soil, China.....	.035	.170	.12
4640	Surface soil, Winnsboro.....	.014	.016	.05
3335	Houston black clay, Waco.....	.020	.....	.....
3336	Houston black clay subsoil, Waco.....	.019	.....	.....
3343	Crawford clay, Waco.....	.024	.....	.....
3353	Upland surface soil, Denton.....	.018	.....	.....
	Average of 24.....	.0203	.0174	.15

COMPOSITION OF THE ETHER EXTRACT.

The products from each four soils were combined, saponified, and the saponifiable separated from the unsaponifiable, according to the methods given in Bulletin No. 150 of this Experiment Station. The results of this work are presented in Table 2.

The ether extracts of the soil were straw colored and often had a greenish tinge. After separation, the saponified products were brown and straw colored and were not homogeneous. The unsaponified matter showed a tendency towards crystallization on long standing. The products apparently contain both the fatty acids and the waxes which

were previously extracted by us from plants. The fatty acids from the 24 soils were combined, and the neutralization number determined. It was found to be 177.0. Another estimation of the neutralization number of the fatty acids from four soils only, was 167.9. This may be compared with 179.8 for archidic and 166.0 for erucic acid. Palmitic acid has a neutralization value of 219.1, stearic acid of 197.5, oleic acid of 198.9 and di-hydroxystearic acid of 177.6.

Table 3 compares the average composition of the ether extract of plants and of soils. The average composition of the two are closely related.

Table 2—Ether Extract—Saponified and Unsaponified Products in Percentage of Soils.

	Saponified	Unsaponified	Total Ether Extract
3363-3620-3662-4344.....	.008	.011	.018
3357-3399-3427-3613.....	.004	.008	.016
4544-4565-4605-4640.....	.007	.011	.023
110-124-142-829.....	.008	.009	.018
1209-1259-1267-1279.....	.011	.012	.025
114-330-845-1131.....	.007	.010	.022
3335-3336-3343-3353.....	.011	.008	.020
Average.....	.008	.010	.020
Per cent.....	40.0	50.0	.....

Table 3—Average Percentage Composition of the Ether Extracts of Plants and Soils.

	Plants	Soils
Unsaponified.....	58.	50.
Saponified.....	36.	40.
Loss.....	6.	10.

COMPOSITION OF THE CHLOROFORM EXTRACT.

The chloroform extracts from six soils were combined and separated into saponified, unsaponified and insoluble. The chloroform extracts of the soils were straw-colored or brownish. After separation, the unsaponified was brownish in color and showed a tendency towards crystallization on long standing. The results are given in Table 4. On an average of the 24 soils the chloroform extract consists of 43 per cent. saponified, 36 per cent. unsaponified, 3 per cent. insoluble and 18 per cent. loss. The loss may be partly due to materials soluble in water and not very soluble in ether.

Table 5 compares the composition of the chloroform extract of Johnson grass with the average composition of the chloroform extracts of soils. Like the composition of the ether extracts of plants and soils, the chloroform extracts are closely related.

Table 4—Chloroform Extracts, Products in Percentage of Soils.

	Saponified	Unsaponified	Insoluble	Loss	Total Chloroform Extract
114-330-845-1131-3620-4568.....	.005	.006	.000	.000	.011
110-124-142-829-1209-1251.....	.010	.007	.001	.005	.023
3399-3427-3662-4344-4544-4605..	.006	.003	.000	.005	.014
1267-1279-3357-3813-3363-4640..	.008	.008	.001	.003	.020
Average.....	.0071	.006	.0005	.003	.017
Per cent.....	43	36	3	18	.....

Table 5—Average Percentage Composition of the Chloroform Extracts of Johnson Grass and of Soils.

	Johnson Grass	Soils
Unsaponified.....	25.	35.
Saponified.....	a 57.	b 43.
Loss.....	18.	18.

a This represents the sum of the saponified, chlorophyll and weak acids which would be included as "saponified" in the method used on soils.

b This represents the sum of the saponified and insoluble which would be included as "saponified" in the classification given in "a."

SUMMARY AND CONCLUSIONS.

(1) Twenty-eight soils contained on an average 0.0203 per cent. ether extract, and a subsequent extraction with chloroform removed 0.0174 per cent.

(2) The ether extract of the soils is composed of 50 per cent. unsaponifiable, 40 per cent. saponified, and a loss of 10 per cent. It is nearly the same as the average composition of the ether extracts of plants.

(3) The chloroform extract consists of 36 per cent. unsaponifiable, 43 per cent. saponified, 3 per cent insoluble and 18 per cent. loss.

(4) The ether extract probably contains fatty acids and wax alcohols.