2. The volatil acidity was equivalent to about 140 cc. 0.1 N alkali, or 0.84% by weight.

3. Of the total volatil acids, 17% was formic, 75% was acetic, 8% was propionic, and 0.6% butyric.

4. No esters were found in this silage, but simply the free alcohols. A trace of aldehyde was also found.

5. The volatil alcohols, expressed as their corresponding acids, amounted to 68 cc. 0.1N alkali, or 0.31% by weight of ethyl alcohol.

6. Of the total alcohols, 21% was methyl,[1] 72% was ethyl, and 7% propyl.

THE OCCURRENCE OF LACTIC ACID IN SISAL.

By Wm. McGeorge.

Received August 19, 1912.

It has been known ever since the sisal plant (*Agave Sisalana*) has been in use as a source of fiber that the juice from these leaves which is crushed out during the decortication is very destructive to the parts of the decorticating machinery with which it comes in contact, as well as to the hands of the laborers who are required to handle the wet fiber as it emerges from the mill. In spite of this fact, few investigators have attempted an identification of this acid. During a recent study made by this laboratory upon the chemical nature of the sisal plant,[2] the identification of this acid was given considerable attention.

So far as I have been able to ascertain from literature at hand, only one claim has been made as to the nature of this acid and that by M. D'Herelle,[3] who is calling attention to the strong acidity of this plant juice, says it is due in part to oxalic acid. However, he cited no proof as to this statement, and probably made the statement only as a theory. I was unable to obtain a test for oxalic acid from a solution of the plant juice, but upon strongly boiling the leaves with hydrochloric acid a very faint test for oxalate was obtained, indicating the possibility of the presence of this acid in minute quantities.

On extracting the leaves with ether, then alcohol, then water, all three extracts gave an acid reaction to litmus, but from none of these extracts was I able to effect a crystallization of any organic acid. Fermentation of the juice goes on quite rapidly and the acidity increases in so doing.

On failure to obtain any crystallization a decision was reached that the acid was one that normally had no crystallin form. Accordingly 500

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[1] While the method of analysis used showed the presence of methyl alcohol, it is barely possible that the formic acid may have arisen from the oxidation of substances other than this alcohol.

[2] Hawaii Exp. Sta., *Press. Bull.* **35**.

[3] *J. Agriculture Tropicale*, June, 1910.

grams of the leaves were boiled in water, a small quantity of sulfuric acid added and the extract thus obtained concentrated upon the water-bath. In this manner, a comparatively concentrated solution of the acid was obtained. This extract was placed in a separatory funnel, extracted several times with ether, the ether removed from the ether extract by evaporation, and this residue taken up in water. This solution had the following properties:

1 Decolorizes potassium permanganate solution in the cold in acid, alkalin and neutral solutions.

2. Bitter taste and is strongly acid to litmus.

3. No visible color reaction with ferric chloride.

4. It is non-volatil at the boiling point of water, but by distilling the leaves from a copper retort the distillate remains neutral until a temperature of 130° is reached, at which point the distillate gives an acid reaction. It may be of interest to state at this point that 130° is the temperature at which lactic acid is decomposed on distillation, one of the products of which is lactic anhydride, and that lactic acid is not volatil without decomposition.

5. Acid is soluble in water, alcohol and ether.

6. The acidity of the plant juice increases on standing to a maximum and then decreases, after which the acid formed is not the same as that originally present, but is non-volatil at the temperature of boiling water and possibly butyric acid.

These properties indicated the identity of the acid as being lactic and in view of this fact the above tests were repeated upon leaves obtained from plants grown on the Experiment Station grounds, the juice of which was extracted as soon after cutting as possible. In this manner was eliminated the possibility of the lactic acid being formed by lactic fermentation which is known to take place in silage, etc.

A sample thus obtained gave the above reactions, and in order to definitely identify it the following conclusive tests were made: A sample was subjected to Uffelman's[1] test for lactic acid and gave a decidedly positive reaction. In view of the further fact[2] that this reagent has recently been found to also react with oxalic, citric, tartaric and succinic acids, these were carefully tested for with negative results. Another delicate test for lactic acid recommended by Georges Denigès,[3] namely, treatment with concentrated sulfuric acid and an alcoholic solution of guaiacol, gave a positive reaction. In this reaction the sulfuric acid converts the lactic acid into acetaldehyde, the presence of which is shown in the subsequent coloration formed in contact with the guaiacol.

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[1] *Z. klin. med.*, 7, 392.

[2] *Expt. Sta. Rec.*, 23, 115.

[3] *J. Chem. Soc.*, 96, II. 627.

Following these tests, a portion of the acid was subjected to analysis by the Palm method.[1] In this analysis the percentage of PbO obtained by incinerating the precipitate of lead lactate, $3PbO_2(C_3H_6O_3)$, was found to be 78.36 and 78.07 in two separate precipitations. The theoretical percentage is 78.50. Crystals were also obtained by treatment with zinc oxide, which resembled zinc lactate crystals under the microscope but no chemical analysis of these was made to positively identify them as such.

The above tests were considered sufficient to warrant the conclusion that the normal acidity of the sisal plant is due to the presence of lactic acid. While this acid is said to exist normally in many seeds, its presence in plants as a normal product of vegetation has been given little consideration, and to my knowledge sisal is the only plant known to develop this acid as its normal vegetable acid.

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NEW BOOKS.

Handbuch der Mineralchemie Bd. I, 6 (Bogen 51-64 und Titelbogen). By C. DOELTER, et al. Dresden: Theodor Steinkopf. Price, M 9.10

With this issue, Vol. I of Mineralchemie is concluded. The final sections are devoted chiefly to the silicates in their relations to industry. About 50 pp. by Dittler and Von Arlit are given up to the consideration of cements, including the newest literature and a bibliography of the subject. Zschimmer, of Jena, in the section on glass, considers the manufacture briefly; the chemical composition and properties of good and bad glass, more fully. He discusses a large body of data on the deterioration of glass under atmospheric influences and its decomposition by water and other reagents which will be of interest to all chemists. There is a section on glazes and enamels by Berdel and another on slags by J. H. L. Vogt. In the latter, the well known author presents some interesting problems regarding the relative composition of slags and metals. The mineral chemist will find in this volume plenty of suggestions for new researches, and the student who has a taste for exact measurement will see in it an abundance of crude data which need to be replaced. An appendix of additions and corrections and an extensive index contribute essentially to the value of the volume. E. T. ALLEN.

Introduction to the Study of Minerals. By AUSTIN FLINT ROGERS, PH.D., Associate Professor of Mineralogy and Petrography, Leland Stanford, Jr., University. New York: The McGraw-Hill Book Co. 522 pp., 5 x 7 1/4. Flexible leather, $3.50 (15s) net, postpaid.

This admirable book of Prof. Rogers has as its stated purpose to cover "the whole field of mineralogy, so far as practicable," and to give "the

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[1] THIS JOURNAL, **9**, 16; **31**, 1365.