The ratio between the per cent bismuth and the per cent tartaric acid indicates that the compound is sodium-tetra-bismuth tartrate.

The per cent sodium agrees more closely with the value for sodium-tetra-bismuth tartrate than with the value for sodium-tri-bismuth tartrate.

The loss in weight at various temperatures indicates that the compound may contain as much as 1.0 to 1.5 per cent of adsorbed water, but loss in weight at the higher temperatures seems mainly due to chemical decomposition.

The determinations for carbon dioxide indicate that the compound contains about one per cent of sodium carbonate or bicarbonate.

SUMMARY.

A study has been made of the composition of a sodium-bismuth tartrate prepared by the method of Kober. Indications are that the compound is a sodium-tetra-bismuth tartrate.

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LACTIC ACID TESTS.

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While lactic acid has been the subject of much work by food analysts and physiological chemists, the literature of pharmacy has furnished very few papers on tests for this acid. This is undoubtedly largely due to the fact that the average market prices of lactic acid have run somewhat higher than citric and tartaric acids and that there has been no temptation to use it as a substitute for the popular fruit acids or preparations containing them. On the other hand, there was at least one period during the past decade when the potential sources of lactic acid were more available to American users than were those of the fruit acids; in fact, it seems probable that larger supplies of and lower prices for lactic acid would prevail should a more pressing demand be created.

In view of this possibility, tests for lactic acid in the presence of other organic acids are desirable and requests for the study of this problem were made a few years since by the U. S. P. Committee on Revision (*a*). One answer to this request came from Germuth and it is his procedure upon which we began our studies. Finding the Germuth test insufficient for all circumstances, we proceeded to an examination of the literature and to a checking up of the testing methods suggested. This paper reports our findings.

The lactic tests found in the literature may be grouped as follows:

A. Thiocyanate Tests.—These tests, reported on by Mendelsohn (*b*) and by Germuth (*c*) are based upon the red coloration produced with a strongly acidulated (HCl) solution of potassium thiocyanate when lactic acid is present. Of course, a similar red color is produced when even traces of iron are present, and this Germuth not only recognizes but also provides for in his method by directing that the red

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color should not be discharged upon the addition of a saturated solution of mercuric chloride. The addition of this mercuric reagent discharges the color of the ferric thiocyanate but does not affect the color produced by lactic acid. We can confirm the importance of this phase of the Germuth Test and can recommend the test if strong lactic acid or commercial calcium lactate are under examination. However, when the test is intended for the detection of lactic acid as an impurity or adulterant in pharmaceuticals (*e. g.*, Solution of Magnesium Citrate), the test does not measure up to the requirements of the case and that for following reasons:

1. Solution of Magnesium Citrate and similar pharmaceuticals almost invariably contain appreciable traces of ferric salts.

2. In the average lactic concentration of such a pharmaceutical, the amount of saturated solution of mercuric chloride required to discharge the color of the ferric salt will also cause a fading by dilution of the lactic color reaction.

An interesting side light upon this thiocyanate reaction is the fact that when the saturated solution of mercuric chloride is added for bleaching purposes, a precipitate is invariably produced in the case of lactates and not so likely to be formed in the cases of citrates and tartrates. This precipitate (mercuric lactate?) we studied in an endeavor to utilize it in our lactic test, but failed to obtain satisfactory results.

B. Oxidation Tests.—A number of tests are found in the literature in which lactic acid is oxidized with permanganate or with chromic mixture to acetaldehyde or other oxidation products, which are then detected by the usual color reactions. Among these tests may be cited those suggested by Schoorl (*d*); Thomas (*e*); Scebezenyi (*f*) and Pittarelli (*g*).

We checked up these tests but cannot recommend them. Again we were confronted by the fact that the pharmaceuticals for which the lactic acid test might be applied were apt to contain citric or tartaric acids and that these acids under similar oxidizing treatment yield aldehyde.

C. Barium Lactate Tests.—These tests depend upon the formation of barium lactate which is soluble both in water and in strong alcohol; thereby permitting the separation of lactic acid from the insoluble barium salts of a number of other organic acids. Such tests have been suggested by Muller (*h*); Kunz (*i*); Möslinger (*j*); Legler (*k*) and Trummer (*l*).

We tried out the Möslinger method on Solution of Magnesium Citrate in the following modified form:

> To 10 cc. of the citrate solution, we added barium hydroxide, barium chloride, again some barium hydroxide and lastly 50 cc. of 95 per cent alcohol. The mixture was allowed to stand a few minutes and then filtered. The alcoholic filtrate (containing the barium lactate) was evaporated to dryness, the residue was treated with 10 cc. of 10 per cent sulphuric acid and the resulting barium sulphate was filtered off. The filtered solution of lactic acid was shaken out several times with 20-cc. portions of ether and the mixed ethereal extracts were evaporated at 90° C. When lactic acid had been added to the original citrate solution, a syrupy residue was here obtained. This residue when dissolved in water was submitted to the resorcinol-sulphuric acid color test for lactic acid.

This method, in our hands, gave accurate results. It was, however, too time-consuming for application in a pharmacopœial test.

D. Insoluble Lactate Tests.—According to Fresenius' "Qualitative Analysis" basic stannous lactate is insoluble in water; zinc lactate occurs in crystals that are sparingly soluble; while lead lactate is almost insoluble.

Lactic acid tests based upon separation of the zinc salt have been suggested by Palm (*m*); Buchner and Meisenheimer (*n*); and Suzukii and Hart (*o*). An assay as lead lactate was devised by Palm (*p*). As this lead precipitation has been condemned by later investigators, we did nothing with it, but we attempted separations of lactic acid by means of its zinc and tin salts, without, however, very great success.

E. Distillation Methods.—Textbooks and investigators suggest the possibility of distillation of lactic acid from tartaric and citric acids by use of a current of superheated steam. According to Partheil and Hübner (*q*) the separation can be accomplished at 130° C. In our experiments we were unable to obtain satisfactory results by this method. We also attempted a separation by the formation of ethyl lactate and distillation of the resultant product. This also failed to produce satisfactory results.

F. Miscellaneous Tests.—In our search of the literature, we ran across a number of tests for lactic acid that did not fall into any of the five groups given above. Among these we may cite the tests suggested by Crouer and Cronheim (*r*) based upon the formation of iodoform; by Nelson (*s*), a modification of the Kunz Test (*i*) with the final identification of acid as quinine lactate; and finally by Grüss (*t*), a microchemical test based upon the formation and study of cobalt lactate crystals. None of these methods seemed sufficiently practical for our purposes to justify extended work along the lines suggested.

G. Solvent Extraction and Color Tests.—Obviously a large number of investigators have endeavored to separate lactic acid from other organic acids by use of immiscible solvents. This method has been hindered by the fact that chloroform and ether exert but little solvent upon lactic acid especially in diluted solution.

On the other hand we agree with the findings of Ohlsson (*u*) that ethyl acetate is a satisfactory extraction solvent for lactic acid. Once the acid is separated in fairly pure form, the most practical type of test would be one of the several color reactions that have been suggested for the acid. Among these we may cite:

Fletcher and Hopkins (*v*)	Lactic acid plus sulphuric acid plus copper sulphate plus thiophene; cherry red.
Brauer (*w*)	Lactic acid plus resorcinol plus sulphuric acid; red.
Hartwig and Saar (*x*)	Lactic acid plus sulphuric acid plus guaiacol; red.
Ekkert (*y*)	Lactic acid plus sulphuric acid plus pyrocatechol; blood red.
Desche (*z*)	Lactic acid plus carbazol plus sulphuric acid.

Of these, the resorcinol test of Brauer was found to be the most satisfactory to use and by combining extraction with ethyl acetate and application of the resorcinol test to the extract we devised the following satisfactory test for lactic acid in pharmaceuticals:

The preparation (in our work, 25 cc. of Solution of Magnesium Citrate) is shaken out with 20 cc. of pure ethyl acetate. When separation occurs, the lower aqueous layer is drawn off, the ethyl acetate solution is left in the separator until any water that was not removed in the first separation settles out, when it is drawn off. The aqueous fluid may, of course, be shaken out

with two other portions of ethyl acetate if deemed advisable. The mixed ethyl acetate extract is washed first with 5 cc. of distilled water and then 5 cc. of diluted sulphuric acid. The washed ethereal solution is then filtered through a dry filter paper and is evaporated on a water-bath until the ethyl acetate has completely dissipated. If a syrupy residue remains it may be weighed as lactic acid. If the test is merely qualitative, the residue is dissolved in 5 cc. of a one per cent resorcinol solution and this solution is layered upon 5 cc. of concentrated sulphuric acid. If the mixture, upon standing for two minutes, followed by gentle rotation, shows a red color, the presence of lactic acid is indicated.

In conclusion we may state that ethyl acetate is the only solvent that we have used which removes the lactic acid without taking with it traces of sugar, citric acid or tartaric acid. Even then, the careful washing of the ethyl acetate extract is essential since these three substances may be mechanically carried over with the ethyl acetate unless the latter is carefully washed. These three substances must be completely removed, otherwise they interfere with the resorcinol test.

BIBLIOGRAPHY.

(*a*) Cook, JOUR. A. PH. A., 16 (1927), 268.
(*b*) Mendelsohn, *Chemist-Analyst*, through *Year Book of Pharm.*, 59 (1922), 148.
(*c*) Germuth, *Ind. Eng. Chem.*, 19 (1927), 852.
(*d*) Schoorl, *Z. angew. Chem.*, 13 (1900), 367.
(*e*) Thomas, *Apoth. Ztg.*, 22 (1907), 206.
(*f*) Scebezenyi, *Z. anal. Chem.*, through A. PH. A. YEAR BOOK, 7 (1918), 494.
(*g*) Pittarelli, *Rept. Pharm.*, through *Drug. Circ.*, 65 (1921), 50.
(*h*) Muller, *Bull. soc. chim.*, through *Chem. Cent.*, 68 (1897^{I}), 87.
(*i*) Kunz, *Unters. Nahr. u. Genussm.*, 4 (1901), 673.
(*j*) Möslinger, *Ibid.*, 4 (1901), 1120; *Z. öffentl. Chem.*, through *Chem. Cent.*, 74 (1903^{II}), 1386.
(*k*) Legler, *Arb. Inst. Dresden*, through *Chem. Cent.*, 79 (1908^{I}), 299.
(*l*) Trummer, *Z. Landw. Oesterr.*, through *Chem. Cent.*, 79 (1908^{II}), 101.
(*m*) Palm, *Z. anal. Chem.*, 22 (1883), 223.
(*n*) Buchner and Meisenheimer, *Ber.*, 37 (1904), 425.
(*o*) Suzukii and Hart, *J. Am. Chem. Soc.*, 31 (1909), 1366.
(*p*) Palm, *Z. anal. Chem.*, 26 (1887), 33.
(*q*) Partheil and Hübner, *Arch. Pharm.*, 241 (1903), 421.
(*r*) Crouer and Cronheim, *Biochem. Cent.*, through *Analyst*, 30 (1905), 403.
(*s*) Nelson, *J. A. O. A. C.*, 9 (1926), 331.
(*t*) Grüss, *Wochschr. Brau.*, 45 (1928), 16 (*Chem. Abs.* (1928)).
(*u*) Ohlsson, *Skand. Arch. Physiol.*, through *J. Chem. Soc.*, 110 (1916^{II}), 542.
(*v*) Fletcher and Hopkins, *J. Physiol.*, through *J. Soc. Chem.*, 92 (1907^{II_B}), 373.
(*w*) Brauer, *Chem.-Ztg.*, 44 (1920), 494.
(*x*) Hartwig and Saar, *Chem.-Ztg.*, through *J. Soc. Chem. Ind.*, 40 (1921), 368A.
(*y*) Ekkert, *Pharm. Zentrahalle*, 66 (1925), 552.
(*z*) Desche, *Biochem. Z.*, 189 (1927), 77 (*Chem. Abs.* (1928)).

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