On a Method for the Determination of Sodium Iodide in Animal Tissues

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ON A METHOD FOR THE DETERMINATION
OF SODIUM IODIDE IN ANIMAL TISSUES

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ON A METHOD FOR THE DETERMINATION OF SODIUM IODIDE IN ANIMAL TISSUES.

By Paul J. Hanzlik.

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Owing to the vast amount of work that has been published in recent years on iodine-containing organs, there have coincidently arisen new methods for the determination of iodine. If one carefully scrutinizes the literature, it is apparent that really only one method has been used and subjected to minor modifications. This one basic method has been confined mainly to comparatively small quantities of iodine, such as the investigators have encountered in the thyroid gland, for instance. Where it is desirable to work with large quantities of iodine in the form of iodide, it will be readily realized that it is not only inconvenient, but also inaccurate to use the colorimetric method intended only for small quantities of iodine or iodide.

Rabourdin\(^1\) originally devised the method used by Baumann and Ross\(^2\), Oswald\(^3\), Howald\(^4\), Anten\(^5\), Loeb\(^6\), Marine and Williams\(^7\) and others.

The principal modifications proposed by Oswald and Anten were the use of the nickel crucible instead of the silver crucible by Oswald and the substitution of carbon disulphide for chloroform as a solvent for the liberated iodine by Anten. With respect

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\(^1\)Rabourdin: Liebig's Annalen, lxxxvi, p. 375.
\(^3\)Oswald: ibid, xxiii, p. 265, 1897.
\(^4\)Howald: ibid, xxiii, p. 209, 1897.
\(^5\)Anten: Arch f. exp. Path. u. Pharm. xlviii, p. 331, 1902.
\(^6\)Loeb: ibid, lvi, p. 320, 1907.
\(^7\)Marine and Williams: Archives of Internal Medicine, May, 1908.
to an oxidizing and fusing capsule, the glazed porcelain dish is equally as serviceable as a nickel dish. The advantages of carbon disulphide, if any, are confined to the colorimetric method. The most recent method proposed for the determination of iodine is that of Hunter. It is claimed that this method excels the various modifications of the original in "cleanliness, convenience, rapidity and accuracy." I have no experience with this method, but the methods heretofore used are not unduly complicated, nor exceedingly long when one becomes fairly accomplished in the actual usage of some one form or modification. Lack of detail furnished by the authors of the respective methods may perhaps account for objection to their usage in unskilled hands. It is the object of this paper to present briefly, but with sufficient explanation, a method not at all original, which has proven successful in our work.

The question of the selection of a method for the quantitative determination of sodium iodide arose in connection with a study of the absorption of this salt from the alimentary canal. The method had its inception in a former study on phenol absorption but it has required further development in order to be utilized directly in connection with sodium iodide. Baumann found that the colorimetric method was inaccurate for quantities of iodine greater than 1.5 mgs. corresponding to 1.77 mgs. of sodium iodide, since the fine gradations between the colors of the chloroform solution were frequently missed; and in using large quantities of the thyroid gland, other organic substances or impurities gave the chloroform a peculiar tint which obscured or modified the violet color obtained with pure iodine. This experience of

2 Sollmann, Hanzlik and Pilcher: Journ. of Pharm. and Exp. Therap. i, no. 4, p. 409, 1910.
Baumann was repeated in our work. It was then proposed to use a volumetric method. In its entirety it consists of a combination of the fusion and oxidation method of Rabourdin with the titration of the iodine in chloroform by sodium thiosulphate according to Fresenius.\(^1\) While Fresenius used carbon disulphide as a solvent for the iodide, chloroform was found to be equally satisfactory.

Working with quantities 100 to 200 times as those of Baumann and others, and with organs larger; oftentimes with an unequal distribution of the sodium iodide; it was necessary to use the whole organ for oxidation and fusion.

The procedure may be divided into three parts:

I. Dessication; II. Fusion and Oxidation; III. Titration.

I. Dessication. The organ and contents are carefully mixed in a porcelain evaporating dish, by cutting the tissue into fine shreds, with scissors. Then the utensils are washed with a small quantity of distilled water into the minced mass. To the tissue are next added 3 to 5 cc. of 40 per cent sodium hydroxide and the whole is placed in a drying oven not exceeding 100 C. until the contents are dry. Sodium hydroxide is added to prevent the escape of any free iodine that may be liberated at this stage or during the later stages of fusion.

II. Fusion and Oxidation. When the contents of the dish are dry, it is placed over a gentle flame, the drying being continued until a black charred mass remains. Care must be taken that the flame does not rise to bring the mass to redness. At this point, considerable evolution of moisture, acrolein, carbonaceous matter and malodorous fumes takes place so that the process is best conducted under a hood. When the contents are thoroughly dried and charred (usually requiring about two hours), a fusing

mixture consisting of equal parts of sodium nitrate and sodium carbonate is added gradually with a spatula until all carbonaceous matter is oxidized, leaving a white residue. After the fused mass has cooled, it is moistened with a small quantity of hot distilled water by washing down the sides of the dish. It is then triturated and taken up with more hot water, the sides of the dish being thoroughly rubbed down with a rubber-tipped glass rod; the whole is filtered, and the filter washed with hot distilled water until no more iodide appears in the filtrate. The filtrate is then made up to a definite volume (250 cc. being a convenient quantity (and an aliquot portion (50 cc.) taken for titration.

III. Titration. To 50 cc. of filtrate in a separating funnel of 250 cc. capacity add gradually and with agitation 10 to 15 cc. of concentrated sulphuric acid. At this point a portion of the iodine will make its appearance giving the liquid a brown cast. Too much acid should not be used, since the heat of solution may raise the temperature high enough to volatilize the liberated iodine; but the solution must be strongly acid to litmus paper. A small quantity (pinch) of crystalline sodium nitrite is added. This liberates the remainder of the iodine which is then shaken out repeatedly with 10 cc. portions of chloroform until the chloroform no longer acquires a violet tint. The chloroform solution is then washed with distilled water until it remains neutral and, finally, titrated directly with N/10 sodium thiosulphate until chloroform solution remains colorless.

One cubic centimeter of N/10 sodium thiosulphate is equivalent to 0.01498 gram of sodium iodide.

Several steps in the process require particular attention. First, oxidation must be conducted slowly and carefully so that it does not reach a bright red heat, since then there would be a
loss of the iodide by volatilization. Second, one must always make certain with litmus paper that sufficient sulphuric acid has been added. Third, the chloroform-iodine solution must be washed with distilled water until it remains neutral, for if the solution should be acid then upon titration with sodium thiosulphate iodine will be liberated from the sodium iodide. A very small amount of acid in the chloroform-iodine solution was observed to bring about this disturbance. In such a case more sodium thiosulphate is utilized than actually necessary for the iodine contained and the iodine value will be too high.

Control Experiments.—In procuring data, portions of the alimentary tract of cats and dogs were used as the animal tissues. In each case loops of intestine of varying lengths and the stomach were ligated at opposite ends and the circulation from each severed in the dead animals. Then a solution of sodium iodide of a known strength in water was injected and allowed to stand different lengths of time ranging from ten minutes to two hours. At the end of their respective periods of time, the tissues were excised and carried through the analytical process. The results will be found in the following table:

<table>
<thead>
<tr>
<th>EXP.</th>
<th>ANIMAL</th>
<th>ORGAN</th>
<th>SOJOURN</th>
<th>INTRODUCED</th>
<th>RECOVERED</th>
<th>LOSSE—GAIN</th>
<th>PERCENT RECOVERED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cat</td>
<td>Loop of ileum 10 cm.</td>
<td>½ hour</td>
<td>0.0073</td>
<td>0.0936</td>
<td>0.0037</td>
<td>96.19</td>
</tr>
<tr>
<td>2</td>
<td>Cat</td>
<td>Loop of ileum 90 cm.</td>
<td>½ hour</td>
<td>0.0073</td>
<td>0.0936</td>
<td>0.0000±</td>
<td>100.00</td>
</tr>
<tr>
<td>3</td>
<td>Cat</td>
<td>Whole stomach</td>
<td>10 min.</td>
<td>0.0073</td>
<td>0.0936</td>
<td>0.0037</td>
<td>96.19</td>
</tr>
<tr>
<td>4</td>
<td>Cat</td>
<td>Loop of ileum 10 cm.</td>
<td>10 min.</td>
<td>0.0247</td>
<td>0.0234</td>
<td>0.0013</td>
<td>97.73</td>
</tr>
<tr>
<td>5</td>
<td>Cat</td>
<td>Loop of ileum 10 cm.</td>
<td>½ hour</td>
<td>0.0073</td>
<td>0.0936</td>
<td>0.0000±</td>
<td>100.00</td>
</tr>
<tr>
<td>6</td>
<td>Dog</td>
<td>Loop of ileum 90 cm.</td>
<td>½ hour</td>
<td>0.0073</td>
<td>0.0936</td>
<td>0.0022</td>
<td>97.73</td>
</tr>
<tr>
<td>7</td>
<td>Dog</td>
<td>Loop of ileum 10 cm.</td>
<td>2 hours</td>
<td>0.0073</td>
<td>0.0936</td>
<td>0.0000±</td>
<td>100.00</td>
</tr>
<tr>
<td>8</td>
<td>Dog</td>
<td>Loop of ileum 10 cm.</td>
<td>15 min.</td>
<td>0.1947</td>
<td>0.1962</td>
<td>0.0015±</td>
<td>100.76</td>
</tr>
<tr>
<td>9</td>
<td>Cat</td>
<td>Loop of intestine 90 cm.</td>
<td>10 min.</td>
<td>0.2921</td>
<td>0.2846</td>
<td>0.0077</td>
<td>97.43</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td>0.1136</td>
<td></td>
<td></td>
<td>97.77</td>
</tr>
</tbody>
</table>

Table of Results
DISCUSSION.

An average of 97.77 per cent of sodium iodide recovered from an average of 0.1136 gram used seems to justify the use of this method for quantitative work. In three instances 100 per cent was recovered. Why this could not be done in five other cases is not known, while in one instance there was a positive loss of the filtrate from the residue whence the low value of 94.73 per cent. It will also be noted that conditions as to the time of exposure of iodide tissues varied. In an exposure of two hours (Experiment 7) there was recovered 100 per cent, the same being true of a thirty minute exposure (Experiment 2) and practically true for Experiment 8.

This method then is suited for the determination of large quantities of sodium iodide in animal tissues. The factor of unequal distribution of the iodide, complicated with the fusion and oxidation of large masses of tissue, does not seem to affect its recovery. The data for this method were obtained with quantities of sodium iodide 15 to 172 times greater than can be accurately determined by the Baumann method. It also incurs practically no loss of iodide which is bound to occur when portions of a composite sample for analysis are used. By this procedure comparatively large organs can be utilized, no portioning being necessary, therefore eliminating this error. It served with no loss in three instances, and only an average loss of 2.23 per cent in all instances when pieces of intestine ranging from 10 to 90 cms. in length were used.

Thanks are due to Prof. T. Sollmann for careful criticisms and suggestions on this work.