

SOME STUDIES OF IODINE OR IRON CONTAINING
COMPOUNDS OF MEDICAL INTEREST

Thesis
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PUBLISHED WORK

- (1) The Microdetermination of Soluble Iodides with N-Bromosuccinimide, *Microchem. J. (U.S.A.)*, 13, No.4, 517, 1968.
- (2) The Microdetermination of Soluble Iodides in Biological Fluids. *Al-Azhar Medical J.*; Accepted for publication.
- (3) The Determination of Iodine Content of Biological Organic Iodine Compounds. *Al-Azhar Medical J.*; Accepted for publication.
- (4) Ascorbimetry: The microdetermination of Iodine in Gastric Juice. *Al-Azhar Medical J.*; Accepted for publication.
- (5) A Photoelectric Colorimetric Method for the Microdetermination of Adrenaline. *Al-Azhar Medical J.*, 2, 157, 1973.

S U M M A R Y

PART I

STUDIES ON IODINE COMPOUNDS

(1) A new titrimetric method for the microdetermination of soluble iodides, e.g., potassium iodide or cadmium iodide is described. The mechanism of the reaction in the presence of dilute hydrochloric acid is discussed. The determination is done within the limits of 20 mg to 50 ug for potassium iodide and from 15 to 1 mg *for* cadmium iodide. The experimental error does not exceed $\pm 2\%$. Comparative analysis of potassium iodide by the proposed method and the official potassium iodate method is reported. The method has been applied successfully to determine potassium or sodium iodide in certain pharmaceutical preparations.

(2) A modified method involving the use of standard N-bromosuccinimide solution for the microdetermination of soluble iodides in biological fluids is described. The proposed method is simple, rapid and highly

sensitive to determine as low as 50 ug of potassium iodide. The experimental error does not exceed $\pm 2\%$. Recovery of potassium iodide from such biological fluids as milk, blood or urine gives reproducible results.

(3) A modified method for the microdetermination of soluble iodides with N-bromosuccinimide is shown to be suitable for the determination of iodine in organic compounds. The determination of the iodine content of iodoform and thyroxine is reported. The proposed method has also been applied successfully for the determination of iodine in tablets and ointments containing organic iodine compounds. The experimental error does not exceed $\pm 2\%$.

(4) The microdetermination of iodine in test solutions by standard L-ascorbic acid solution in presence of starch indicator solution is shown. The experimental error does not exceed $\pm 2\%$. Comparative analysis of iodine shows that L-ascorbic acid surpasses sodium thiosulphate method in sensitivity and accuracy

when iodine is to be determined in minute amounts. Application of standard L-ascorbic acid for the micro-determination of iodine in gastric juice gives reproducible results.

PART II
STUDIES ON IRON COMPOUNDS

(5) A modified permanganate method for the micro-determination of ferrous iron is described. The proposed method is highly sensitive to determine amounts as low as 10 ug of ferrous iron. Comparative analysis of ferrous iron by the modified method and the original permanganate method is reported.

The determination of ferrous iron content of tablets is shown. The method is suitable to determine ferrous iron in presence of ferric iron.

(6) A photoelectric colorimetric method for the microdetermination of adrenaline in test solutions is

described involving the use of dilute alkaline potassium ferricyanide solution. The intensity of the colour depends upon the amount of adrenaline present. The proposed method is sensitive to determine amounts as low as 25 ug of adrenaline. Application of the proposed method to determine adrenaline in injections is reported.

REVIEW OF LITERATURE ON IODINE[‡]
AND IODINE COMPOUNDS

A) IODINE:

Iodine, a non-metallic element was discovered in 1812 by the French Chemist Courtois while working with the ash of sea-weeds. In 1814 it was named by Gay-Lussac after the Greek word ἰοειδής (ioeides) meaning violet, due to the colour of its vapour. It is a constituent of sea water and certain algae which have the power of concentrating it from sea water and storing it in their tissues. In Chile saltpeter, it is present in the form of sodium iodate and from which iodine is prepared.

Iodine is prepared by ashing sea-weeds which contain from 0.2-2% iodine, then treating the ash with hot water, and by the addition of sulphuric acid, hydroiodic acid is liberated, from which iodine is released by manganese dioxide. The iodine is then distilled out of the mixture and purified by sublimation.

Iodine as a Member of Halogens:

Iodine is one of the halogens. It resembles chlorine and bromine in its chemical properties, but it is

[‡] When compiling this review the Dispensatory of U.S.A. 1960 was consulted.

somewhat less active. It forms salts with most of the elements. Its important acids include hydroiodic acid, iodic and periodic acids. These acids form the corresponding series of salts. Iodine is insoluble in water, but it is easily soluble in aqueous solutions of alkali-iodides to form triiodides, e.g., KI_3 . Iodine sublimes easily with heat in the form of dark violet vapours, and this property is made use of in its purification.

Distribution of Iodine:

Iodine is present in plant foods grown on iodine-containing soil, animals foods derived from animals fed on such iodine-containing plants and in sea-products. Certain districts in the world are deficient in iodine and in these regions goitre is common. Iodine deficiency and the resulting deficiency of thyroid hormone lead to excessive thyrotrophic hormone (TSH) production. It was found that 150-300 micrograms of iodine are enough per day for an adult. In U.S.A. - 0.01% of potassium iodide is added to table salt (Kimball, 1946). In coastal regions iodine does not represent a problem, because sea-food provides sufficient iodine for most individuals.

Absorption Metabolism and Excretion of Iodine:

Iodine is easily absorbed from the gastro-intestinal tract. After that, it circulates in the blood and is concentrated in the thyroid gland. Then intracellularly in the thyroid, the iodide under the influence of peroxidase-like enzymes, forms iodinated tyrosine in protein combination. Oxidative condensation of iodinated tyrosine forms the thyroxyl groups of thyroglobulin, which is stored in the acinar colloid of the gland. Proteolysis of thyroglobulin releases thyroxine, tyrosine and iodide. The thyroxine enters the blood stream to reach the tissues, while the iodide and tyrosine give rise to new thyroglobulin in the thyroid gland.

Iodine is easily absorbed from the gastro-intestinal tract and skin. It was found that iodine is excreted largely in the urine. In addition to excretion in urine, it is secreted in gastric juice and saliva in concentrations about 30 times that in blood plasma. Traces of iodine are also present in tears, sweat, milk, spinal fluids and serous effusions. (The Dispensatory of U.S.A., 1960).

In the blood, iodine circulates chiefly as thyroxine, which is loosely bound to serum albumin (Laidlaw,

1949). Thyroxine iodine may be separated from inorganic iodine by precipitation of the serum proteins; this is the plasma protein-bound iodine. Total serum iodine includes inorganic iodide and varies with the iodine content of the diet and the use of medicinal iodine. The level of protein-bound iodine increases in hyperthyroidism and decreases in myxedema (Mann et al., 1942), and it is correlated in general with the basal metabolic rate of the individual. In normal individuals about 4-8 micrograms of protein bound iodine per 100 ml. of blood is found (The Dispensatory of U.S.A., 1960).

Therapeutic Uses of Iodine:

Concerning its therapeutic use, iodine was first employed therapeutically in 1819, by Coindet of Geneva, in the treatment of goitre. In current clinical practice mild and uncomplicated cases of hyperthyroidism are prepared for surgical resection of the thyroid by iodide therapy during 1-2 weeks in the hospital. Sodium radio iodide (I^{131}) solution is also injected in cases of hyperthyroidism to cause regression of the hyperplastic thyroid by internal radiation as an alternative method of treatment of surgical resection. Iodine, along with bed rest,

sedation and a high caloric, high protein and vitamin diet, is very important in the preoperative preparation of patients with thyrotoxicosis (either Graves disease or exophthalmic goitre and toxic nodular goitre) for thyroidectomy. Iodine is commonly administered in the form of Lugol's solution. The so-called thyroid-crisis, observed either immediately after thyroidectomy or unassociated with surgery, is one of the dangerous and dramatic complications of hyperthyroidism. For this condition big doses of iodine are given. Patients with non-toxic enlargements of the thyroid, or even those with mild hyperthyroidism, respond well to iodine therapy.

Medically, elemental iodine has two important therapeutic properties which its salts do not share; these are its local irritant and germicidal effects. As a counter-irritant, it is used especially in various forms of arthritis, notably those due to trauma, but it is also effective in bronchitis and glandular enlargement. Its action in these conditions may be supplemented by systemic effects following absorption through the skin. Iodine has also been used for its local irritant effect as an injection for local effusions, such as hydrocele and ganglion, although surgical repair is usually necessary (The Dispensatory of U.S.A., 1960).

Iodine is considered one of the most potent and useful germicides. It was found that in the presence of blood serum a 1 in 2000 solution was bactericidal to staphylococci and surpassed all the mercurials tested (Nye & Baston, 1937). It was found that free iodine concentrations as low as 0.0625 per cent were bactericidal for human tubercle bacilli in cultures and that suspensions of mycobacterium tuberculosis var. Hominis exposed to 0.5 or even 0.05% concentration of free iodine for 5 minutes failed to infect guinea pigs. Also it was found that to kill anthrax spores much stronger solutions are required; the formerly official 7% tincture of iodine required 2 hours for such action. It was also found that a concentration of 0.375 µg of iodine/ml prevented within one minute the appearance of cytopathogenic effects in monkey kidney cells due to Types I and II poliomyelitis virus.

Elemental iodine is also an important disinfectant for drinking water. It was found that a dosage of 8 parts per million of iodine completely destroyed 30 cysts of *Endamoeba histolytica* / ml within 10 minutes in most natural waters. Certain soluble