

its barrel towards a horizontal position the required observation depth of two feet is easily obtained.

Any quickly subsiding material present should be classed as sediment rather than turbidity. To determine the same it would be best to decant the water above such deposit and then catch it upon a weighed filter or in a Gooch crucible.

THE TOXIC ACTION OF SODIUM FLUORIDE.¹

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THE title of this article was suggested by a recent case of accidental poisoning by means of sodium fluoride. The substance is now largely sold as an insecticide put up in tin cans resembling baking-powder boxes. In this way and on account of its now somewhat extended use in the arts there is considerable liability of accidental poisoning from it. The possibility of future accidents, and the fact that in searching for literature on the salt as a toxic agent no record was found of any severe or fatal poisoning, induced the writer to present a brief history of the case together with such other information as could be collected.

Some pan-cakes served for breakfast were partaken of by six or seven persons. Some ate very sparingly, one woman only a portion of one, while one man ate three or four of them. All who had eaten vomited within five to fifteen minutes afterward. In some cases purging occurred, in others it did not. In one case, at least, this purging and occasional vomiting continued for a day or more, with pains in the limbs complained of.

In the case of the man who ate three or four cakes, vomiting commenced early, but he soon recovered sufficiently to attend to his duties as bartender until early in the afternoon when he was obliged to retire to his room. He died early in the evening of the same day, practically without medical attendance. Further symptoms in the case could not be ascertained.

At the time this occurred it was supposed to be a case of criminal poisoning and some milk used in mixing the cakes was suspected. An analysis, by the writer, of this milk and a portion of the viscera of the deceased failed to detect any of the usual mineral poisons. But a small amount (0.007 gram) of what

¹ Read at the meeting of the New York Section, April 7, 1899.

looked like ordinary white sand was separated and preserved.

Further investigation by the authorities resulted in finding a box of roach poison by the side of the baking-powder box and an analysis showed it to consist of sodium fluoride which contained as an impurity a small amount of sand which was microscopically identical with that recovered from the stomach of the deceased.

This served as a clue, and although the contents of the stomach had been destroyed, a little mucus scraped from a small portion of tissue that had remained in the laboratory for six weeks, contained enough of the poison to be detected with certainty.

The mucus was macerated with a little water and filtered. The filtrate was precipitated with calcium chloride and a very small precipitate (probably two or three milligrams) of calcium fluoride obtained. This, after drying, was sufficient, when mixed with a fraction of a drop of sulphuric acid, to strongly etch a piece of glass. The sodium was detected before precipitating by means of flame coloration and the spectroscope.

There was no means of knowing exactly what the fatal dose had been in this case, but judging from the relative amounts of sand in the stomach and the roach poison, it must have been at least ten grams.

The stomach was nearly empty and contained only a small amount of a gray slimy mucus that clung rather tenaciously to the mucous membrane which was somewhat inflamed.

While the above investigation was in progress an almost identical accident occurred in another city. Here fairly accurate data were obtainable regarding the dose and symptoms.

About twenty-six grams of the fluoride were used instead of baking-powder in making twenty-six wheat cakes for breakfast. One brother ate nine, a daughter six, the mother (age sixty-nine) five and another brother one. Assuming the substance to have been thoroughly mixed, the amount taken by each was, respectively, nine, six, five and one grams.

The symptoms varied considerably as follows: The man who had taken nine grams was seized with very violent cramps almost immediately afterward. These continued at frequent intervals for about thirty-six hours and were followed by severe pain for

three or four days before recovery. Purging commenced quite early and vomiting in about four hours. Retching continued for two or three days.

The daughter who had taken six grams felt sick when eating the last cake and vomited in five or ten minutes. Sometime afterward she took some mustard water and vomited again. She felt weak and sick for two days. No diarrhea.

The mother took but five grams but was the most seriously affected of all. Although the nauseous feeling commenced, as with the others, within five minutes, she did not vomit for about five hours. Diarrhea, however, began in fifteen or twenty minutes and was a serious symptom for several days. She was confined to her bed for two weeks with extreme prostration and did not completely recover for four weeks.

Information regarding the heart and lungs could not be obtained in any of these cases.

Three other cases were heard of. One was a man who was made to vomit by merely tasting the substance a few times with the object of finding out whether it was borax or not. Another one (a salesman) had tasted the salt many times a day without any ill effects. The other case was a man who, while intoxicated, took in mistake for Rochelle salts about fifty grains. He was soon taken with violent vomiting and purging but recovered in a few days.

Before these last cases cited came to the knowledge of the writer and before any literature on the subject had been found, he made the experiment of taking a few gradually increased doses of sodium fluoride to ascertain its toxic action upon himself. Merely tasting small quantities produced a slight feeling of nausea with slight salivation. 0.03 gram swallowed with some bread produced no effect. Neither did 0.09 gram taken one hour later, except a little salivation. 0.25 gram, however, taken two days afterward on an empty stomach, produced nausea in two minutes. This gradually increased in severity for twenty minutes when the period of greatest intensity was reached. There was a largely increased flow of saliva and some retching but no vomiting occurred at that time although the desire was very great. The nausea gradually subsided so that luncheon could be eaten (without relish), but vomiting took

place immediately on its completion which was two hours after taking the poison. Slight nausea continued throughout the following day but disappeared on the second day.

Although some of the toxic properties of sodium fluoride have long been known, no reference was found in the literature of anyone who had taken a large dose of it. This is probably due to its very limited commercial use in former days.

As long ago as 1867 Rubuteau¹ in experiments on dogs and rabbits found that in dogs five-tenths gram given by the mouth made them sick but that 0.25 gram was without action. One gram injected into the blood caused serious symptoms but was not fatal. In rabbits 0.25 gram by the mouth made them sick and the same amount injected was fatal.

These results do not agree, as regards the lethal dose, with similar experiments made later by others, and Rubuteau afterward says that the purity of the fluoride used was questionable.

Kolipinski² in 1886 used it medicinally with good results in sympathetic headache, intermittent fever and epilepsy in doses of less than a quarter of a grain, larger doses being liable to cause nausea. He says "that five grains given to a dog on meat produces vomiting in a few minutes which continues until the stomach is empty, and may then cease or end a little later with much retching or ejection of mucus. * * *

"The intravenous injection of a toxic dose (three grains for the cat) produces in this animal and in the dog death in a few hours." * * * With the vomiting may occur evacuation of feces and urine. * * * At intervals there are moments of unrest with twitchings or tremors of the limbs. For the most part the animal is quiet and unconscious. This stage begins with the cessation of vomiting which ends within the first hour. * * * The urine is slightly albuminous and rich in fluorine."

The same authority describes an experiment where he gave at the same time to each of three males one-eighth of a grain of sodium fluoride. The urine voided at that time soon became turbid at the room temperature, while that passed two hours later remained clear for seven days from the preservative effect of the

¹ Etude expérimentale sur les effets physiologiques des fluorures. Paris, 1867.

² *Med. News*, 49, No. 8, Philadelphia, 1886.

fluorine eliminated. Urine passed one to two hours afterward quickly decomposed as usual.

Shulz,¹ 1889, found that when subcutaneously injected, the lethal dose of sodium fluoride was for rabbits 0.2 to 0.4 gram, for dogs 0.3 gram and for frogs 0.005 to 0.006 gram.

Haidenhain,² 1889, stated that 0.05 to 0.10 gram for kilogram of body weight injected into the blood of dogs produced death.

Weinland,³ 1894, in experimenting with the sodium salts of the halogens on mucous membrane from the throat of the frog found that equimolecular solutions killed the membrane in the following orders: Sodium fluoride (two and one-tenth per cent.) in one minute; sodium iodide (seven and five-tenths per cent.) in ten minutes; sodium bromide in forty-five minutes, and sodium chloride (two and nine-tenths per cent.) in sixty minutes.

P. Grützner,⁴ 1893, found the same order of sensitiveness for nerves.

Czrellitzer,⁵ 1895, after reviewing the work of others, concludes that sodium fluoride is an active poison for micro-organisms of all kinds, algae, and nerves and muscles of the higher organisms. He proves that the poisonous action is stronger on some kinds of cells than others. After citing the theories of several authors he believes there is no satisfactory explanation of the way in which it exerts its poisonous action.

It appears from the evidence thus far obtained that the most characteristic symptoms produced by sodium fluoride in the individual are early nausea, vomiting, and salivation. Its detection may be accomplished, as in the case cited, by precipitating the solution with calcium chloride and testing the calcium fluoride obtained for fluorine. The results of Kolipinski's experiments indicate that an examination of the urine would also be important in cases of suspected poisoning.

The facts ascertained seem sufficient to class sodium fluoride among the less violent poisons and as such it ought to find a place in works on toxicology.

¹ Untersuchungen über die Wirkung des Fluornatriums und der Flüssaure: Arch. f. exp. Path. und Ther., 1889.

² Neue Versuche über die Aufsaugung im Dündarm.—Pflüger's Arch., 1894.

³ Ueber Chemische Reizung des Flimmerepithels.—Pflüg. Arch., 58, 1894.

⁴ Ueber Chemische Reizung Motorische Nerven: Pflüg. Arch., 53, 1893.

⁵ Zur Kenntniss des Fluornatrium, Inaugural Dissertation, Breslau, 1895.