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Hygienic Analysis of some of the Potable Waters of Brookings

Lloyd E. Work
South Dakota State University

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HYGIENIC ANALYSIS

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While it is universally recognized that there is a difference between good and bad drinking water, few realize how important a part water plays in producing or destroying health.

Comparatively recent investigation has ~~been~~ shown that water forms the most active agent in the production as well as the promotion and spread of disease.

Water containing organic impurities will, when used, cause various forms of disease, while if the water of a well which has received the excreta of a patient suffering from some infectious disease, be drunk, the drinker is almost sure to contract the disease.

Pure water may be said not to exist, and the term is only a relative one, meaning water which contains so little more than the theoretical "H_2O" that it may be considered as pure. Any matter, therefore, which may be discovered in water, outside of the elementary Oxygen and Hydrogen, may be designated as an impurity.

The character of the impurities differs necessarily with the source of the water. In water from mineral springs and deep bored wells the impurities are generally entirely mineral in nature. Such water may be said to be periodide of mercury just commences to be formed. The solution is then left for about 20 hours and 160 grammes of caustic potash added, after which it is rendered more sensitive by the addition of more mercuric chloride and diluted up to one litre. (3) Standard solution of ammomium chloride For this solution 3.15 grammes of solid ammomium chloride are dissolved in one litre of water. Onecc . of this solution should contain just 1 milligramme of ammonia. (4) A dilute solution of ammomium chloride made by diluting some of the standard solution to one hundred times its volume, making each cubic centimeter of the dilute solution to contain 1/100 of a milligramme of ammonia. (5) Solution of potash and potassium permanganate. To make this solution 200 grammes of stick potash and 8 grammes of crystalized potasium permanganate are dissolved in 1 litre of water, this liquid is then boiled to about two-thirds its volume, to destroy any organic nitrogenous matter or ammonia present, and diluted up to 1 litre. (6) Standared soap solution made by dissolving 10 grammes of pure, powdered castile soap in 1 litre of 35% alcohol.

Each cubic centimeter of this solution should contain sufficient soap to precipitate 1 milligramme of lime.

In addition to these solutions, water absolutely free from ammonia is necessary for nesslerizing. It was prepared in this instance by adding bromine fumes to distilled water, in a stoppered bottle until the water was just perceptibly colored after shaking. A drop of strong soda solution (sodium carbonate) was added and the bottle again shaken. After standing about ten minutes a few drops of potassium iodide were added to destroy the excess of hypobromite. This water was found to give no ammonia test.

The determination of ammonia is made by taking 500cc of the sample of water to be analyzed and placing in a hard glass retort connected to a large condenser. A Bunsen flame is then applied to the naked bottom of the retort and the water is boiled until 50cc. have distilled over. This first distillate is nesslerized. The total amount of free ammonia in the 500cc. is found by multiplying the amount of ammonia in the first distillate by $4/3$.

The distillation is continued until 150cc. more have come over. These are thrown away and to the remaining 300cc. in the retort, 50cc. of the solution of potash and potassium permanganate are added and the distillation proceeded with. After three successive distillates of 50cc. each have been collected, distillation is stopped and these are analyzed. The total ammonia in the three shows the albuminoid ammonia present in 500cc.

The nesslerizing process is performed by taking 50cc. of the distillate to be tested and adding 2cc. of the Nessler reagent. If ammonia be present it will be shown by the liquid striking a reddish brown color, varying in intensity with the amount of ammonia present. The exact amount of ammonia is determined by finding the amount necessary to imitate the color given by the distillate. In order to do this a known amount of the standard solution of ammonium chloride is diluted up to 50cc. and 2cc. of the Nessler reagent added. The two are placed side by side on some white surface and the color produced artifically is compared with that of the distillate. If the shade is not the same, another trial is made with a different amount of the ammonia solution. This operation is repeated until the color given by the distillate is exactly immitated. The amount of ammonia in the distillate is then the same as that used in imitating it.

To determine the chloride, 70cc. of the water are placed in a perfectly clean porcelain evaporating-dish. Three drops of potassium chromate are added as an indicator and the standard solution of silver nitrate added drop by drop, from a graduated burette, into the water. The addition of silver solution is continued until the red silver chromate becomes persistent. The chlorine is then all precipitated. Since the number of milligrammes of chlorine precipitated by each cubic centimeter of the silver solution is known, we have only to multiply by the number of cubic centimeters used in precipitation of the chlorine in the water, to determine the number of milligrammes of chlorine in 70cc. of water, which number corresponds to the number of grains of chlorine in one gallon of water.

The total solids are found by the slow evaporation to dryness of 70cc. of water. The weight of the residue in milligrammes will exactly correspond to the number of grains of solids in one gallon of water.

Hardness is found by means of the standard solution of soap. 70cc. of water are measured into a stoppered bottle and shaken. The soap solution is added, one cubic centimeter at a time, until a lather is formed, on shaking, which will persist for five minutes. The number of cubic centimeters of the solution used in producing a permanent lather measures the number of degrees of hardness of the water. The number of grains of carbonate of lime contained in a gallon of water is found by subtracting from the number of degrees of hardness, one degree (which is used by the water itself) e.g., in water of 15° hardness the grains of carbonate of lime present number 14.

In reports of tests, the ammonia is given in parts per million, which is the same as the number of milligrammes in each litre of water. Chlorine and solids are reported in grains per gallon, or milligrammes per 70cc.

The waters analyzed may be considered as representative of the different kinds now used for drinking purposes in Brookings. They were carefully collected in clean one gallon jugs and analyzed immediately after they were obtained. With the report of each analysis is given a description of the well from which the sample was obtained.

SAMPLE I.

Water was secured from tap in Chemical Laboratory and came from well on college farm, although it is probable that the water tested had stood a short time in tank before it was examined. The well from which it came is hand dug, about 38 feet in depth and 8 feet in diameter, curbed with brick laid in Yankton cement. The water flows into the well from an underflow about 8 feet thick, in coarse gravel, lying just above a bed of blue clay. The soil above the gravel is yellow boulder clay. The well constantly contains from 10 to 15 feet of water. Several barns are within a radius of 200 to 400 feet. Iron pump.

Results of Analysis.

Free ammonia (parts per million).	0.0066.
Albuminoid " " "	0.1145
Chlorine (grains per gallon).	1.9
Total solids " " "	49.1
Hardness	22°

(Solid residue gave test for carbonates).

SAMPLE II.

This water is from a well on college grounds, between two of the main buildings and is on the top of a slight eminence. It is hand dug to the depth of 37 feet. The curbing from the bottom to within about 12 feet from the top is of brick, the rest of pine. The top is tightly covered with plank. The pump is iron.

Results of Analysis.

Free ammonia (parts per million).	0.02332
Albuminoid " " "	0.11250
Chlorine (grains per gallon).	1.25
Total solids " " "	44.8
Hardness.	14°

SAMPLE III.

Water from cistern near ladies' dormitory on college grounds. This cistern is a large one lined with brick in Yankton cement, and water is taken out by means of an old wooden pump. The water, which runs from the roofs of the college buildings, had probably come from recent rains, although the exact time it had been in the cistern is unknown.

Results of Analysis.

Free ammonia (parts per million).	1.13
Albuminoid " " " "	0.45
Chlorine (grains per gallon).	0.14
Total solids " " "	5.15
Hardness.	4°

SAMPLE IV.

From a well on residence lots of D. J. Darrow in East Brookings. Well is about 70 feet deep and contains a considerable amount of water which is of a muddy appearance owing to the blue clay in it. The well is dug in blue clay all the way down from the loam. The curbing is of wood, and the pump is an iron force pump.

Results of Analysis.

Free ammonia (parts per million).	0.58
Albuminoid " " "	0.25
Chlorine (grains per gallon).	0.45
Total solids " " "	112.5
Hardness.	31°

SAMPLE V.

Water from a deep drilled well on the residence lots of H. Fishback in North Brookings. This well is 465 feet deep and the water comes from a bed of sand at that depth. Water presents a rather milky appearance, which deepens upon standing, and has a taste indicative of the presence of iron. The well is piped with two inch galvanized iron pipe. The pump is of iron and is run by wind power. Previous to the time of taking the sample the pump had been working for some time.

Results of Analysis.

Free ammonia (parts per million.	4.85
Album. " " " "	0.68
Chlorine (grains per gallon).	3.48
Total solids. " " "	229.4
Hardness..	43°+

Note. - Qualitative tests showed presence of potassium, sodium, magnesium and calcium, also of sulphates and carbonates.

SAMPLE VI.

Water the same as Sample V, except that it was heated to 100°C. before analyzing. The heat precipitated a quantity of mineral salts and made the water quite clear.

Results of Analysis.

Free ammonia (parts per million). 4.10

Album. " " " " 0.59

Chlorine (grains per gallon). 3.50

Total solids. " " " 221.7

Hardness. . . . . 42°

(Residue gave tests for carbonates).

SAMPLE VII.

Water from a well at the rear of the Central House, Brookings. The well is just back of the hotel and numerous out-houses and a livery barn are in the immediate vicinity. No further data in regard to this well could be secured.

Results of Analysis.

Free ammonia (parts per million). 0.05

Album. " " " " 0.18

Chlorine (grains per gallon). 21.5

Total solids." " " 121.9

Hardness. . . . . 36°

(Residue gave test for carbonates).

SAMPLE VII.

Water from a well on the residence lots of Prof. B. T. Whitehead, east of Brookings. Well is 68 feet deep. The soil in which the well is dug is sandy on the surface, below the sand and gravel is about two feet of blue clay, then yellow clay in which are several small veins of water above where the underflow which furnishes the main supply, is reached. The curbing is of pine and the pump of iron. When the sample was taken, the well was newly dug and the water had been in use but a few days.

Results of Analysis.

Free ammonia (parts per million).	2.16
Album. " " " "	.18
Chlorine (grains per gallon).	.56
Total solids." " "	142.1
Hardness.	38°

(Residue gave test for carbonates).

SAMPLE IX.

From a well on the residence lots of P. J. Hegeman, in East Brookings. The well is about 50 feet deep, dug by hand to the depth of 43 feet and drilled the remainder of the way with a test auger. The curbing is of wood and the pump iron. The soil is yellow clay. A barn is about 30 feet away and the privy is about 40. The covering is of plank.

Results of Analysis.

Free ammonia (parts per million).	.62
Album. " " " "	.15
Chlorine (grains per gallon).	4.93
Total solids." " "	118.9
Hardness.	44°

SAMPLE X.

Water from a flowing well on the farm of John H. Overa, of Canton, South Dakota. This well is 42 feet deep, dug with a 12 inch auger and curbed with boards. It was dug about four years before the analysis was made and had been flowing over the top continuously up to the time of taking the sample, at the rate of about 3 gallons per minute.

This artesian water was analyzed partially to show the difference between it and the surface waters as found at Brookings.

Results of Analysis.

Free ammonia (parts per million)	3.94
Album. " " " "	.17
Chlorine (grains per gallon)	.70
Total solids. " " "	212.
Hardness	63°

Note - Qualitative tests showed the presence of calcium, sodium, magnesium, and of sulphates and carbonates.

It will be seen that the samples of well water have, with one or two exceptions contained reasonably small amounts of ammonia. In sample V, where ammonia was found in an unusually large quantity its presence cannot be explained as the water from so deep a well can scarcely be polluted by drainage of any kind, when tightly cased as is the well in question. In the othersamples the quantity of organic matter varies with the surroundings of the well.

The solid matter has been shown to vary greatly with the different wells, the most being found in waters containing the greatest amount of mineral salts in solution. The chlorine was found in rather large quantities in several of the samples, notably in VII, but here it can hardly come from the presence of animal excreta for if it did it would be accompanied by a larger amount of ammonia than was found in the water.

The well waters all contain sufficient lime to produce considerable hardness but this property is characteristic of western waters and can scarcely be called a serious objection to their use.

Taken as a whole, we may say that the potable waters of Brookings are on the average good, extremely good, perhaps, when compared with those usually used in this region of country.