THESIS

THE CHLORINE CONTENT OF WATER

BY

Thorn Smith.

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The Chlorine Content of Water.

That contaminated water is a means of conveying disease of the most loathsome and malignant forms is, in the light of modern science a fact not to be disputed. Bacteriological investigation has shown beyond doubt that the specific micro-organisms of our common diseases, find contaminated water a culture ground. The minuteness of the organism prevents the acceptance of the statement by the uneducated and it is to a great extent they who are most often affected with the contagious diseases. The educated too, are wofully negligent of their water supply. That the prevalence of a disease in a locality is due to specific organisms found in the water cannot be always proven, is not absolute proof that they do not exist there or that the use of the water is safe. Neither is proof that the organisms existing in the water of a locality where the public health is good will not at some time invade the economy and produce the most direful results. Examination of the well-water from a chemical standpoint in localities in which diseases of a certain nature occur will generally reveal the fact that the water is contaminated. By contamination is meant a suspicious amount of organic matter due generally to an animal source. A further examination will often reveal the presence of micro-organisms in the water. In proof of this statement a few instances will not be out of place.

Typhoid fever is a disease, which, it has been proved beyond doubt, drinking water will convey disease to a whole neighborhood. The report for the Michigan Board of Health for the year 1879 gives several instances in which the outbreak was

directly traceable to the drinking water used. The well was situated near the barn, as so many country wells are, the ground was clay, which probably for a long time prevented contamination by leaching. A number were sick at various times and finally by the advice of an intelligent physician an analysis of the water was made. The free ammonia and also the albuminoid ammonia existed in exceeding large amounts. The amount of chlorine showed undoubted evidence of animal contamination. In the report of 1889 another instance is given in which chlorine and ammonia were present in large amounts. In the water were found bacteria to the number of 140 per drop. Hundreds of cases which were directly traceable to the use of drinking water have been reported to the Board of Health since its organization. In 1890 eighteen per cent of the cases reported were classified as having been caused by the use of impure water. Other diseases such as scarlet fever, diptheria, and small-pox, although not proven, are generally thought to be conveyed by means of drinking water. No standard of purity can be formulated which will adapt itself to every water but the general opinion seems to be in favor of the following which is given in part.

Chlorine,- not over 10 parts per 1,000,000

Ammonia,-

Albuminoid,-not over .15 parts per 1,000,000

Free - - - " " .10 " " "

These three elements in excess of the above figures will condemn any water and further examination of the surroundings will generally reveal the source of contamination.

Now the question arises, is any one of the elements alone an indication of contamination? It is obvious that ammonia either

free or albuminoid is direct evidence that organic matter is, or has been,present. But is chlorine, an inorganic substance, an evidence of contamination? Chlorides are characteristic ingredients of both human and animal excretions and as such are found mainly in the urine. It is obvious then, that a considerable amount of chlorine is found on analysis is an indication, other things being equal, that the water has been contaminated by animal excrement. Nearness to the sea,mineral springs,or salt deposits of any kind, are of course exceptions. The chlorine in itself is not harmful but serves as the danger-signal for other and dangerous elements. While the ammonia in either form can be found in many waters are are just as dangerous it is seldom that when chlorine is detected, we do not find the ammonia in proportionately large amounts.

I have undertaken in this investigation to determine First;- "What reliance can be placed upon an excessive amount of chlorine in a water as regards contamination"?

Second;- "What bearings do the surroundings of a water supply have on the chlorine content"?

Third;-"Is a standard requiring less than 10 parts of chlorine per 1,000,000 a correct one"?

Fourth;- "The general source and condition of the farmers' water supply."

The water was collected in clean glass bottles of 250 cubic centimeters capacity and careful notes taken of the well's surroundings. The distances from barn, out-house, or any other source of contamination, also any information volunteered by the owners. A standard solution of Silver Nitrate, one cubic centimeter of which equalled .001046 grams of chlorine was made up

and the same standard used throughout the tests. Chromate of Potash was used as an indicator, the end reaction being sharply defined. 50 cubic centimeters of water were titrated in each estimation and the results calculated to parts per 1,000,000. In all ninty-one analyses were made, the results of which are here tabulated. The work was all done by numbers and when a sample containing an excessive amount of chlorine was compared with the notes taken it was invariably found that the sorroundings of the supply were questionable.

Chlorine Parts per 1,000,000.

No.	Am't.	Remarks.
1	10.46	Barn 50 feet from the well.
2	52.30	Out-house 50 feet from the well.-See notes.
3	10.46	Very close to the barn.
4	12.55	An old barn site is twenty feet from the well.
5	10.46	30 feet from the barn and 40 feet from out-house.
6	66.94	Slops are emptied near the well.- See notes.
7	10.46	Very close to the barn.
8	8.77	Barn 60 feet from the well.
9	12.55	Out-house 50 feet from the well.
10	41.84	Out-house 100 feet from the well.
11	10.46	No buildings near the well.
12	140.87	An open well. - See notes.
13	10.46	No buildings near the well.
14	16.74	In a barn-yard.
15	66.94	Out-house 80 feet from the well.-See notes.
16	25.10	Out-house 50 feet from the well.-See notes.
17	92.05	Out-house 75 feet from the well.-See notes.
18	31.39	Barn 50 feet from the well.- See notes.
19	58.58	Out-house 25 feet from the well.-See notes.
20	15.34	No buildings near the well.
21	23.01	Very close to the barn.- See notes.
22	8.37	Considered the best water in the vicinity.
23	37.66	Out-house 30 feet from the well.-See notes.
24	8.37	Out-house is 40 feet from the well.
25	15.34	Out-house is 30 feet from the well.-See notes.
26	36.26	No buildings near the well.-See notes.

27	8.37	Out-house 30 feet from the well.
28	41.84	Out-house 40 feet, and barn 60 feet from well.
29	57.18	Out-house 75 feet from the well.-See notes.
30	58.58	Out-house 60 feet from the well.-See notes.
31	19.87	Out-house 50 feet from the well.
32	Trace	Water from brook in wild garden.
33	Trace	Close to the barn.-See notes.
34	20.92	Very close to the barn.
35	4.18	Spring Brook Dairy Farm.
36	4.18	School well.
37	4.18	Out-house 60 feet distant;barn 40 feet.
38	10.46	Out-house 20 feet from well.-See notes.
39	4.18	In the middle of a barn yard.
40	6.27	10 feet from the residence.-See notes.
41	6.27	Out-house 30 feet distant;close to the barn.
42	4.18	Barn 30 feet distant.
43	4.18	Barn 50 feet distant.
44	6.27	Very close to the house;out-house 40 feet.
45	19.87	Close to house;out-house very near.-See notes.
46	8.37	House 20 feet distant;50 feet from barn.
47	6.27	Barn 50 feet distant;40 feet from out-house.
48	4.18	Some distance from any buildings.
49	4.18	Some distance from any buildings.
50	4.18	Very close to house;50 feet from out-house.
51.	4.18	House 30 feet distant;out-house 40 feet.
52	8.37	Very close to house;out-house 40 feet.
53	4.18	Barn and out-house 50 feet distant.
54	6.37	Close to house;out-house 50 feet distant.
55	10.46	50 feet from out-house.

56	41.84	Very close to the house.-See notes.
57	16.74	Close to the house;60 feet from out-house.
58	75.31	Close to house.-See notes.
59	33.48	Out-house 100 feet distant.-See notes.
60	8.37	Close to house.
61	43.93	Very close to the house;- See notes.
62	6.37	Close to the house.
63	16.74	Close to the house.
64	4.18	Out-house 30 feet distant.
65	10.46	Very close to the house.
66	8.37	10 feet from the house.
67	6.37	Close to the house.-See notes.
68	12.55	City water of Lansing.
69	8.37	Grand River water at Lansing.
70	4.18	Cedar River water at the College.
71	6.37	See notes.
72	4.18	Under house;new well.
73	6.37	Close to house; 50 feet from the barn.
74	6.37	House 20 feet distant; out-house 20 feet.
75	4.18	Close to house; Bad sanitary surroundings.
76	4.18	Close to house; 40 feet from out-house.
77	81.59	Holly water from Jackson.-See notes.
78	10.46	Otherwise a very poor water.- See notes.
79	10.46	100 feet from out-house and below level.
80	47.00	50 feet from out-house and below level.
81	41.8	200 feet from out-house.
82	20.92	100 feet from out-house.
83	16.73	A very good water.
84	12.55	A very good water.

85	28.40	Grand River water.-See notes.
86	42.60	Cedar River water.-See notes.
87	21.28	See notes.
88	28.40	See notes.
89	17.75	See notes.
90	Trace	College artesian well.
91	4.18	Spring near Cedar River.

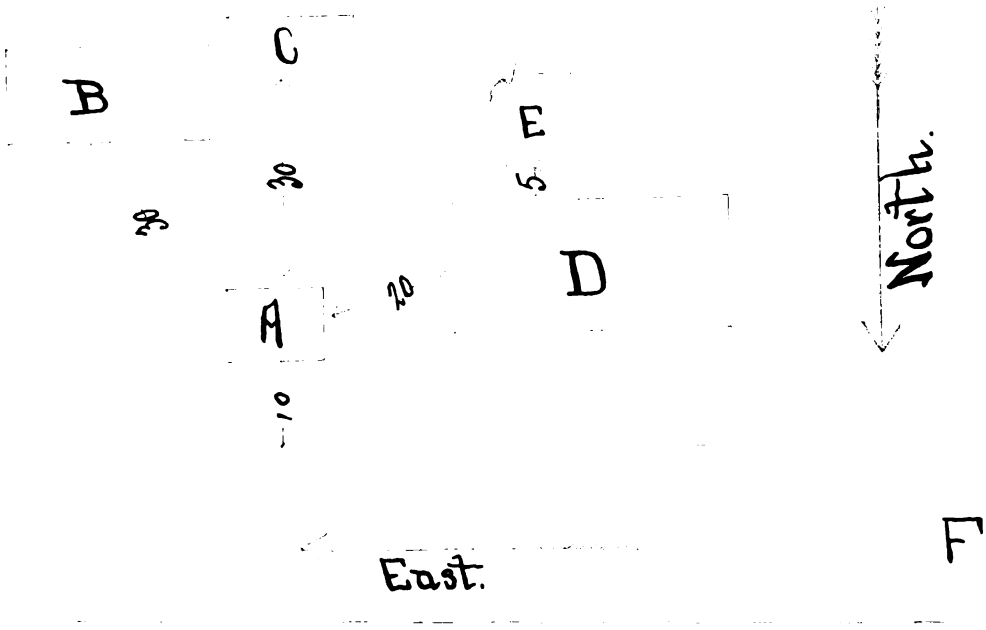
Number 2 is the first water that arouses suspicion and further inquiry reveals that the out-house is but a short distance from the well. The well is here very close to the house and contamination is evident.

Number 6.- In this case the well is near the house and dish-water and other house-refuse are thrown near the well. Contamination from this source is evident.

Number 10.- No apparent cause for the excess.

Number 12.- This sample created suspicion when collected and it was no surprise to find such an amount of chlorine. By reference to the diagram the cause and source of this element can readily be seen. The sample was taken from an open tile-well on the east and west road about four miles from the college. The condition of the farm shows an utter lack of care and if disease has not here made its appearance it is because the residents possess immunity. The well is about ten feet from the road and water is drawn with a pole. The land slopes from the south and on the side which the dwelling and farm buildings stand, towards the well. The owner in drawing the water tips the bucket towards the north side of the well because as he says,"The water comes from that way and is much colder than after it has stood awhile in the open well." The house is an old log building and immediately back of it and at a distance of forty feet from the well is a large manure pile. The barn is fully as old as the house and in a bad condition. It is thirty feet from the well and sorrounded by manure. The out-house is forty feet distant and may contribute its quota. The soil is clay and whether the water is contaminated by surface or under drainage is unknown. That the water is unfit for use is evidenced by the sorroundings, let alone the analysis.

Diagram of number 12.



A— Well.
B— Barn.
C— Out-house.
D— Dwelling.
E— Compost Heap.
F— Road.

Number 15.- This well is above the scrrounding buildings and the source of contamination is not evidenced.

Number 16.- Out-house is fifty feet from the well and the well is below the general level.

Number 17.- In this case house-slops and refuse are emptied near the well and probably account for the excess of chlorine exhibited.

Number 18.- The barn is 50 feet distant and may account for the excess.

Number 19.- The out-house is twenty-five feet from the well and above the general level which in all probability accounts for the excess.

Number 25.- This sample was taken from a foul-looking spring which supplies a family with water. The spring is about thirty feet from the out-house and much below the level. It is a most filthy looking source of supply.

Number 26.- Source of contamination not found.

Number 28.- Contamination from barn or out-house.

Number 29.- Contaminated probably by same causes as in the previous.

Number 30.- Contaminated by the same causes as the previous two samples.

Number 34.- Is very close to the barn. This may be a cause of contamination.

Number 45.- Close to the house and the out-house is very near.

Number 56.- Very close to the house. Slops are probably emptied near the well which contaminate it and cause the excess.

Number 58.- This well is very close to the house and house refuse is thrown very near it.

Number 59.- No apparent cause for the excess.

Number 61.- Very close to the house and the general sanitary condition of the premises is bad.

Number 77.- This water was received for analysis from Jackson, Michigan. The sorrounding conditions are unknown.

Number 80.- The closeness of the out-house probably accounts for the excess.

Number 81.- No apparent cause for the contamination.

Number.-85.- This water was taken from the Grand River at Lansing, July 28.1893 at the time the city was infected with diptheria. The ammonia was not present in excess and the mere presence of the water was not considered deleterious.

Number 86.- This water was taken from the Red Cedar River at the same place and time as the preseeding. The ammonia content was not large and the water was considered in the same light as the above.

To further verify the assertion that the above waters high in chlorine are unfit for use a partial analysis was made of the ammonia content with the following results.

Number 58.- An exceeding large amount of Ammonia was found.

Numbers,-34, 43, 45 and 59, all contain ammonia far in excess of the standard.

Numbers,-87, 88,89 were waters analyzed in this laboratory in 1893 to determine if their contamination had any bearing on several diptheria cases which had occured in Lansing during the year. There was nothing found in the mere chemical analysis however to arouse suspicion.

Number 71,- This is taken from a well at least one-half mile from any possible source of contamination.

Number 33.- The ammonia,nitrates, and other dangerous element in this water proved on examination to be exceedingly high. The well is close to the barn and may or may not be contaminated.

The general lay of the country in which the greater part of these samples were collected is level with but few hills. The soil is mostly clay, but in a few localities there is considerable sand.

The first question,-" What reliance can be placed upon an excessive amount of chlorine in a water as regards contamination?" is answered to a great extent by the above. Wherever an excess of chlorine is found, with but few exceptions the sorroundings of the well indicate contamination from animal sources. And again wherever the chlorine content is high, the ammonia content is in excess of what the standard permits and the ammonia is a positive indication of a poor water. A few assays give a large amount of ammonia with but little chlorine. They are in the minority however. The amount of chlorine then found in a water is an indication, but not absolutely so, of contamination. The second question,-" What bearings do the sorroundings of a water supply have on the chlorine content"? In 90% of the cases in which the chlorine content is found to be high the sorrounding conditions are such that suspicion is aroused. In number twelve the slope of the land and the general shiftlessness of the farm would lead one to distrust the water. In many instances however the surroundings are exceedingly bad while there is but little chlorine found in the water. As a rule however, we may say that unhealthy sorroundings will generally reveal a large excess of chlorine in the well-water.

The third question,- "Is a standard requiring less than 10 parts of chlorine in a 1,000,000 a correct one?" This is somewhat difficult to answer. Number 71 with 6.37 parts paer 1,000,000 would seem to support the claim. Several of the tabulated

samples give as high as 30 parts, yet the sorroundings are very good and there is no apparent contamination. The Chicago Board of Health has fixed the limit at 15 parts per 1,000,000 and this seems more reasonable. No absolute standard can be fixed for any state or community. 15 parts per 1,000,000 however, seems much more reasonable than 10 parts, in the light of the above tables.

The fourth question.-"The general source and condition of the farmers' water supply?"

This is a question on which many are well informed. The general opinion is that a well in one place is as good as in another and a great many place it in the barn yard or very close to it. Of the ninty-one samples collected but two were taken from open wells. About forty per cent are located within fifty feet of the barn yard. About fifteen per cent are near the house where house-slops find ready access to the water. But a small number are placed where the sorroundings are above suspicion. The idea that a water may be contaminated by the leaching property of the soil does not seem to enter into the discussion when a location is under consideration. The location and condition then, of farm wells is not by any means what it should be.

The exceeding dryness of the year may have tended to lower a portion of the results, and there is room for extended inquiry into the question of farm water supplies.

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