A BACTERIOLOGICAL SURVEY OF WELL WATERS FROM FOUR CENTRAL KENTUCKY COUNTIES

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In the Drinking Water Standards adopted by the Public Health Service in 1942 is the statement: "A brief summary of the pertinent facts relating to the sanitary condition of the water supply, as revealed by the field survey, should be submitted." Among the pertinent facts are listed, "Nature of soil and underlying strata; depth to water table" and "Nature of rock penetrated, noting especially existence of porous limestone."

In the Sanitation Manual for Ground Water Supplies, 1944, is the statement: "Formations such as limestone, broken lava rock, coarse gravel, and brittle rocks whose interstices are in the form of channels, joints, and fissures, provide little filtering action to prevent contamination from reaching the water-bearing stratum."

In spite of these statements, a search of the literature will reveal a deficiency in studies of the effect of soil and rock types on the sanitary quality of water supplies.

Through the cooperation of the U. S. Geological Survey and the Department of Geology of the University of Kentucky, who have been making a survey of the water supplies of four Central Kentucky counties, Bourbon, Fayette, Jessamine and Scott, it has been possible to obtain samples of water from 73 wells in this area, together with geological data concerning the locations of the wells.

Along with studies to correlate the bacteriological quality of the water with the geological surroundings of the well, studies have been made of the effect of storage of the water samples for 24 and 48 hour periods at room temperature on the results of tests for members of the coliform group in the water. Although the Standard Methods for the Examination of water and Sewage (Ninth edition, 1946) specifies that samples of relatively pure waters shall not be held for more than 12 hours (impure waters waters 6 hours) at 6 to 10 C, the majority of water samples from rural regions in Kentucky are examined only after prolonged storage at room temperature. Many of them are mailed to the laboratories where the examinations are made. The work of Hutchison, 1943, on the influence of the presence of antagonists for *Escherichia coli* in water samples on the results of tests for coliform organisms has suggested that results obtained after such handling of samples may be very unreliable.

Experimental

PROCEDURES

The samples were taken by members of the Geology Department of the University of Kentucky. Three samples were taken from each well, all at the same time, in sterile glass-stoppered bottles of approximately 100 ml capacity. They were brought to the laboratory, uniced. In most cases, the time between sampling and commencement of analysis was less than one hour, and in no case was it greater than two hours.

One of three samples from each well was examined immediately upon receipt in the labortary for bacterial content by means of the standard 37 C plate count and for density of coliform organisms, the most probable number (M. P. N.) being determined. The procedures of the Standard Methods for the Examination of Water and Sewage, 1946, were followed. For the coliform determination five 10-ml portions, five 1-ml portions and five 0.1-ml portions were planted in lactose broth. All positive presumptives were confirmed in brilliant green lactose bile broth.

The remaining two samples from each well were stored at room temperature. At the end of 24 hours, one of the two stored samples was examined for density of coliform organisms, and at the end of 48 hours, the other sample was examined.

RESULTS

The results are included in table 1. Information on depth of wells and rock formations in which the wells are located is also included in the table. In some cases such information was not available.

TABLE 1

BACTERIOLOGICAL RESULTS ON CENTRAL KENTUCKY WELL WATERS

Well No.	Depth feet	Formation at bottom of well	Standard plate count	M. P. N. coliforms† Sample 1	2	3
		FAYETTE COUNTY				
1	120	Curdsville	1	7.8	17	6.1
2	165	Hermitage	5	0	0	0
3	65	Jessamine	70	*1600	350	540
4	2000		2	0	0	0
5	17		140	350	130	240
6	75		230	540	350	*1600
7	195	Hermitage	6600	*1600	920	920
8	185	Tyrone	70	920	540	540
9			70	4	2	4.5
10	185	Tyrone	110	49	0	2
11	180	Curdsville	48	49	23	45
12	85	Jessamine	31	130	130	49
13	65	Hermitage	14	70	33	4.5
14	90	Jessamine	85	17	4.5	6.8
15	28	Jessamine	180	*1600	*1600	*1600
16	42	Jessamine	30	0	0	0
17	78	Hermitage	325	0	0	0
18	135	Jessamine	42	26	33	170
19			375	0	0	0
20	75	Curdsville	270	140	220	170
21	100	Hermitage	2900	26	23	11
22	70		7	2	2	0
23			350	11	7.8	2
24	60	Tyrone	600	*1600	*1600	49
25			34	240	79	14
26	70		5	2	2	0

Well No.	Depth feet	Formation at bottom of well	Standard plate count	M. P. N. coliforms† Sample 1	2	3
			JESSAMINE COUNTY			
27			350	130	79	17
28			500	110	130	
29	14		9,600	*1600	*1600	*1600
30	86		35	4	4	0
31	30		700	81	*1600	220
32	75		*30,000	49	33	17
33	170		2,900	64	540	240
34	65		6	4.5	0	0
35	85		40	49	33	17
			SCOTT COUNTY			
36	135	Jessamine	130	27	4.5	0
37	60	Woodburn	4	14	46	23
38	190	Tyrone	75	49	17	22
39	80		150	6.8	0	0
40	500	Tyrone	110	4.5	0	0
41	100	Curdsville	95	23	4.5	4.5
42	44	Jessamine	85	41	7.8	4.5
43	60-75	Jessamine	1	0	0	0
44	25	Benson	30	240	41	17
45	65	Benson	38	39	140	33
46			30	27	33	33
47	55		15	17	21	13
48	100		2900	7.8	4.5	0
49			140	920	920	33
50	123	Tyrone	15	0	2	1.8
51	76	Jessamine	80	2	2	0
52	75	Benson	85	49	130	920
53	80	Curdsville	110	110	79	130
54	50	Benson	190	540	240	920
55	132	Hermitage	3	0	0	0
56	55	Tyrone	5	2	0	0
57	90	Curdsville	250	*1600	*1600	*1600
58	78	Jessamine	60	350	95	33
59	100	Jessamine	170	0	0	0
60	90-100	Jessamine	85	49	49	4.5
61	84	Tyrone	32	11	11	13
62	150	Tyrone	325	22	23	14
63	135	Jessamine	7	0	0	0
64	135	Jessamine	46	540	7.8	5
65	200	Tyrone	31	350	31	49
66	200	Jessamine	240	540	920	920
67			18	21	2	4.5

Well No.	Depth feet	Formation at bottom of well	Standard plate count	M. P. N. coliforms† Sample 1	2	3
			BOURBON COUNTY			
68	73		30	79	70	33
69			65	240	240	350
70			350	240	*1600	2
71	31		33	1.8	0	0
72	30		5	0	0	0
73	140		85	0	0	0

† Sample 1 examined immediately after arrival at laboratory.
Sample 2 stored 24 hours at room temperature before examination.
Sample 3 stored 48 hours at room temperature before examination.
* Greater than.

In accordance with the usual results of water surveys little correlation can be found between the standard plate count results and the results of the tests for members of the coliform group. Judgment of the sanitary quality of the waters should be based primarily upon the coliform results.

Of the 73 wells examined, 62 (84.9%) were positive for coliforms. Standard plate counts of samples from these wells varied from 1 to greater than 30,000; the median was 80. Of the 62 coliform positive samples, 50 had M. P. N. values of over 10 and the wells may be considered as heavily polluted. Standard plate counts on these samples varied between 4 and greater than 30,000; the median was 85. Standard plate counts on the samples from the 12 lightly polluted wells varied between 1 and 2,900; the median was 33. Standard plate counts on the 11 samples that were negative for coliforms varied between 1 and 375; the median was between 5 and 6. While the wells from which these samples were taken should not be considered as polluted, at least 2, with plate counts of 325 and 375, should be viewed with suspicion.

Rock formations in the region studied are Ordovician, and are primarily limestone formations. No correlation could be found between the specific formations in which the wells were located and the sanitary quality of the water; nor could any correlation be found between the depths of the wells and the sanitary quality of the water. Likewise no correlation could be found with the soil types in which the wells were located. For the sake of brevity, data on soil types have not been included in the table of results.

Samples from 61 of the 62 wells that yielded coliform oryanisms when the samples were examined immediately were studied for the complete storage period of 48 hours.

Of the 61 stored samples, 43 (70.5%) showed decreases in the coliform content during the storage period. Fifteen (24.6%) showed increases. Of the remaining 3 samples, one showed no change in coliform content in the 48 hour period and the other 2 had M. P. N. values greater than 1600, so that the serial dilutions used did not give accurate results.

Of the 62 samples from sources that yielded coliform organisms from the samples that were examined without storage, 6 yielded no coliform organisms after they had been stored for 24 hours at room temperature. Of these, only one was from a source that had a M. P. N. of over 6.8 as determined from the unstored sample. This well had a M. P. N. of 49 from the unstored sample, a M. P. N. of 0 from the sample that was stored for 24 hours, and a M. P. N. of 2 from the sample that was stored for 48 hours.

Of 61 samples from sources that yielded coliform organisms from the samples that were examined without storage, 11 yielded no coliform organisms after they had been stored for 48 hours at room temperature. Of these only one was from a source that had a M. P. N. of over 27 as determined from the unstored sample. This well had a M. P. N. of 540 from the unstored sample, a M. P. N. of 7.8 from the sample that was stored for 24 hours, and a M. P. N. of 0 from the sample that was stored for 48 hours.

Discussion

Little information was available concerning the construction of the wells from which the samples were obtained. It is probable that some of the wells are not so constructed as to avoid the entrance of surface pollution. Allowing for the presence of some wells of this type in the test group, it is still evident that much of the pollution can only be ascribed to the geological features of the region.

It may be concluded that comparatively few unpolluted wells exist in the area studied. Only 15 per cent of the wells studied were unpolluted on the basis of the coliform test as judged by a single sampling. High plate counts indicate that some of these wells might be found to be polluted at certain times if a series of samples were to be examined.

The results obtained with the stored samples emphasize the importance of the Standard Methods limitations on the storage of samples. Quantitative results to indicate the extent of pollution are

almost worthless on samples that have been stored for 24 hours or more at room temperature. Qualitatively, pollution can usually be detected with samples that have been stored under these conditions, provided the extent of the pollution is comparatively great. Positive results on stored samples may be trusted but negative results should be looked upon with suspicion.

Summary

Samples of water from 73 wells in four Central Kentucky counties have been examined. Of these wells 50 were found to be heavily polluted, and 12 to be lightly polluted, as judged by tests for coliform organisms. High plate counts indicate that some of the remaining 11 wells should be viewed with suspicion pending further investigation. The high degree of pollution of well waters in Central Kentucky is associated with the predominantly limestone formation of the region. No correlation could be established, however, between the quality of the well water and the depth of the well or the formation in which the well was located.

Studies on the effect of storage of samples of well water at room temperature before examination emphasizes the importance of following Standard Methods provisions on the handling of samples if corrcet results are to be obtained.

References

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