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DETERMINATION OF FLUORIDE ION IN WELL WATERS OF EASTWOOD SCHOOL DISTRICT, WOOD COUNTY, OHIO[1]

ROSE M. JONES, Eastwood Local Schools, Pemberville, OH 43450
GORDON A. PARKER, Chemistry Department, University of Toledo, Toledo, OH 43606

ABSTRACT. The purpose of this investigation was to determine the amount of fluoride ion present in the well water of Eastwood Local School District, Wood County, Ohio. Ninety-two water samples were gathered from separate wells in the district and analyzed for fluoride content. Fluoride determination was made with a fluoride ion-selective electrode using a direct potentiometric method. pH measurements were also made upon the samples. Fluoride levels were found to range from 0.6 to 3.8 parts per million. pH measurements varied from 6.91 to 8.30.

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INTRODUCTION

Eastwood Local Schools began a weekly fluoride mouthrinse program in the elementary buildings during the 1983-84 school year. Parental permission was required for participation. One child reported that the well water in his home had a high fluoride content and that his mother was concerned regarding excess fluoride (Dean 1936, Walbott 1978).

How much fluoride is too much? What is a toxic level of fluoride concentration? How much fluoride is present in the well water of Eastwood School District? An Honors Science/Math Teacher's Research Project conducted in the summer of 1984 at the University of Toledo provided the opportunity to study the fluoride ion concentration of a representative sample of wells in the Eastwood School District.

METHODS AND MATERIALS

APPARATUS. A fluoride ion-selective electrode, Orion Model 94-09, was used with a Keithley Model 160B digital multimeter adapted to accept an ion-selective electrode and a double junction reference electrode, Orion Model 90-02-00, containing inner filling solution, Orion number 90-00-02, and outer filling solution of 10% potassium nitrate, Orion number 90-00-03. pH measurements were taken using a Corning pH meter, Model 109, equipped with a Corning general purpose pH electrode and the Orion double junction reference electrode. Solutions were stirred with a magnetic stirrer.

REAGENTS. Fluoride standards were prepared by dissolving 4.99 g reagent grade sodium fluoride in distilled water to make a 0.100 *M* sodium fluoride solution. Exactly 100 ml of this solution was diluted with distilled water to one liter to prepare a 0.010 *M* solution. Additional standards to a lower limit of 1.0×10^{-6} *M* were prepared in a like manner. A Total Ionic Strength Adjustment Buffer (TISAB) was prepared by combining 500 ml distilled water, 57 ml reagent grade glacial acetic acid, 58 g reagent grade sodium chloride, and 30 g sodium citrate. The solution was titrated to a pH of 5.0-5.5 using reagent grade 5 *M* sodium hydroxide. Following this, the solution was cooled and diluted to make one liter (Frant and Ross 1968).

PROCEDURE. Ninety-two samples were gathered from several parts of the Eastwood Local School District, Wood Co., Ohio, including the towns of Luckey and Pemberville since these villages, too, get their water from wells (fig. 1). Samples were stored in clean glass bottles. When samples were collected, the bottles were also rinsed twice with water from the respective well. pH levels were obtained by inserting the appropriate electrodes into 25.0 ml of each sample and taking the reading on the pH meter after one minute.

To prepare the fluoride ion calibration curve exactly 50 ml of the standard 0.100 *M*, NaF solution was added by pipet to a beaker. Fifty milliliters of TISAB were added. The solution was stirred for one minute and the electrode potential determined after one additional minute. The same procedure was repeated with all standards and a calibration curve prepared plotting potential as a function of standard fluoride ion concentration.

Exactly 25.0 ml of each unknown sample was placed in a beaker, 25.0 ml of TISAB added by pipet and the mixture stirred for 15-20 sec. Then the electrodes were placed in the beaker and a potentiometric reading taken after one minute. This procedure was followed with all unknowns.

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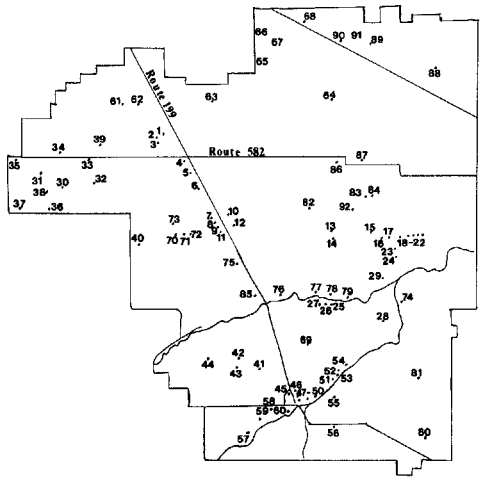

FIGURE 1. Location of well sites within the Eastwood Local School District, Wood Co., Ohio.

RESULTS AND DISCUSSION

Fluoride levels were found to range from 0.6 to 3.8 parts per million with most wells ranging from 1.0 to 3.0 ppm (table 1). This seems to be an excessive fluoride content for cities that fluoridate their drinking water do so at 1.0 ppm level. One part per million is taken to be the optimal amount of fluoride for the prevention of dental cavities in humans (Nat. Acad. Sci. 1977). Even in high fluoride level areas, however, the actual amount of fluoride injested by people would vary because of the different amounts of water taken into the body as drinking water, other beverages, and in foods.

Fluoride levels were found to vary widely even within a relatively small area. Several factors may affect these levels. Note that pH of the water samples and well depth, when known, are also tabulated along with fluoride content (table 1). There may be a relationship between the aquifer, the ground material the water passes through, and the amount of fluoride ion found in the water. According to Scott et. al. (1937), wells in which the aquifer is sand or gravel would be expected to have a low fluoride content while wells in which limestone was the aquifer material would be expected to have a higher fluoride content. This seems to be consistent with the findings presented here, as wells from sand hills had a lower fluoride content. The aquifer composition of area wells located on flat land was not known. Attempts to correlate the data of table 1 (pH, fluoride content and well depth) graphically were unsuccessful, and no statistically significant relationship between these variables was found.

While the presence of some fluoride ion is desirable (Berndt and Stearns 1981), high levels of fluoride ion can cause dental fluorosis. Fluorosis of teeth is taken as an early sign of fluoride intoxication. Even the one part per million fluoride generally available in treated waters is questioned by some (Colquhoun 1985). A questionnaire was sent to 15 area dentists. (table 2) Among the 13 dentists who replied, 10 had seen evidence, in several patients, of mild dental fluorosis, characterised by while spots in the tooth enamel. No mild dental fluorosis was observed by three of the dentists. For a few patients moderate dental fluorosis, brownish spots in the teeth, was witnessed by nine of the dentists replying while four said they had not seen any moderate dental fluorosis. No severe dental fluorosis, characterized by blackened pitted areas in the teeth, was reported by any of the replying dentists.

CONCLUSIONS

The wells of Eastwood Local School District seem to contain a relatively high level of fluoride ion caused perhaps by the underlying limestone aquifer. In addition to dental fluorosis toxic fluoride levels have also been associated with skeletal fluorosis, mongolism and general ill health (Yiamouyiannis 1983) raising concern over the practice of adding fluoride to water supplies already containing natural fluorides (Colquhoun 1985). To the authors' knowledge, except for the dental fluorosis cited, none of the above have been attributed to the fluoride content of well water in the Eastwood School District, and there is no evidence linking any of these illnesses to fluoride ion in this area. The authors agree

TABLE 1

Flouride ion and acidity levels of selected wells in Eastwood School District, Wood Co., Ohio.

Sample No.*	1	2	3	4	5	6	7
Fluoride (ppm)	1.9	1.7	1.9	0.7	1.7	1.5	1.9
pH	7.72	7.48	7.71	7.52	7.30	8.16	7.52
Depth (meters)	29	—	—	18	23	15	—
	8	9	10	11	12	13	14
	1.9	1.9	2.1	1.7	2.1	1.5	1.5
	7.60	7.84	7.55	7.93	7.61	7.57	7.36
	9	27	27	14	23	—	—
15	16	17	18	19	20	21	22
2.1	2.1	2.1	2.1	2.5	1.9	1.9	1.9
7.35	7.36	7.50	7.45	7.87	7.64	7.52	7.40
—	—	26	37	—	24	22	20
23	24	25	26	27	28	29	30
1.9	1.1	1.5	1.1	1.3	1.7	2.1	0.8
8.30	7.92	7.36	7.53	7.57	7.30	7.73	7.25
—	—	14	—	18	26	—	—
31	32	33	34	35	36	37	38
1.5	1.5	2.1	2.7	2.5	1.3	0.6	1.5
7.64	7.50	7.47	7.60	7.47	7.41	7.33	7.36
—	17	21	30	8	14	11	18
39	40	41	42	43	44	45	46
2.1	2.5	2.7	1.9	2.7	1.5	3.4	3.0
7.56	7.63	7.02	7.32	7.36	7.36	7.18	7.56
—	15	—	—	37	14	14	—
47	48	49	50	51	52	53	54
3.0	3.0	3.0	3.4	3.4	3.4	3.0	3.0
7.42	7.77	7.58	7.48	7.55	7.46	7.60	7.64
5	9	14	15	15	10	20	27
55	56	57	58	59	60	61	62
2.1	0.7	3.4	2.1	2.5	3.0	0.8	1.9
7.16	7.41	7.27	7.18	7.10	7.12	7.39	7.42
—	—	15	—	30	—	—	—
63	64	65	66	67	68	69	70
2.1	1.9	2.1	2.5	2.1	2.1	1.5	1.9
7.58	7.62	7.50	7.12	7.28	7.22	7.24	7.46
—	—	—	—	21	—	—	18
71	72	73	74	75	76	77	78
1.9	2.1	2.5	1.0	2.5	2.5	2.5	2.7
7.18	7.20	7.32	7.05	8.05	7.04	6.95	6.91
22	—	18	—	—	—	11	15
79	80	81	82	83	84	85	86
2.5	3.8	2.5	1.5	1.1	1.9	3.0	2.5
7.03	7.00	7.09	7.06	7.25	7.35	7.14	7.16
20	—	18	23	—	—	—	—
87	88	89	90	91	92		
1.0	1.7	2.5	3.0	1.9	1.7		
7.00	7.57	8.18	7.15	6.94	7.12		
—	—	—	—	—	30		

*See fig. 1 for location of well site

with those advocating less fluoride, but recommend that each parent read the sources given here and elsewhere and consult with his or her dentist before allowing his or her child to participate in a school mouthwash program.

TABLE 2

Number of area dentists observing dental fluorosis in patients (13 replies).

Degree of dental fluorosis		Mild*	Moderate**	Severe
Number of dentists	Yes	10	9	0
	No	3	4	13

*Observed in several patients
**Observed in a few patients

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