MINERAL CONSTITUENTS OF HEALTH SIGNIFICANCE OF HAZARA WATER SUPPLIES

Pages with reference to book, From 100 To 105

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Abstract

One hundred water samples collected from different water supply sources in Hazara Division were analysed for their mineral constituents. The concentrations of almost all the mineral constituents did not exceed the desirable limits. Fluorides and iodides were either absent in some samples or were in very low concentrations indicating a possible correlation with the mottling of teeth in children and a high incidence of endemic goitre in the hilly areas of Hazara Division (JPMA 38 :100, 1988).

INTRODUCTION

Practically all the natural waters contain dissolved minerals. Some inorganic substances occur - relatively frequently in drinking water in significant concentrations. When water comes in contact with the soil, rocks or deposits of certain minerals, some of the mineral matter dissolves in it. Sometimes water takes up these minerals from wastes and sewage. In the routine examination of thinking water (which has already been carried out by the authors)[1] some of these constituents are overlooked, but their importance cannot be denied because of the growing population of the world and the interference of man in his surroundings by imparting domestic and industrial wastes to water supply sources. Therefore, search should be made for rare matallic and other chemical factors which may impair acceptability of water[2]. Hence it becomes necessary to analyse water for such substances which are either considered harmful for human health or have some nutritional importance and act as mineral supplement of the diet. In addition to common mineral constituents of water, the present survey was extended to the estimation of silica, as well as lithium which have gained importance in recent years as the expected essential nutrients.

MATERIAL AND METHODS

Water samples were collected in chemically clean bottles by the recommended method of W.H.O[3]. Chemical analysis of the water samples was started soon after the sample was received in the laboratory. Calcium and magnesium were determined by complexometric titration with E.D.T.A. using eriochrome black-T and murexide as indicators. Sodium, potassium, and lithium were determined by flame photometer. Fluoride was determined photometrically by alizarine red-S, iodide by ceric ammonium sulphate method, while silica and phosphate were estimated by ammonium molibdate photometric method. The methods were adopted from the “Standard methods for the examination of water and waste water”[4].

RESULTS

The analytical data has been recorded in tables I - IV.

Table 1

S.No.	Place	Source	Calcium (Ca^{++}) ppm	Magnesium (Mg^{++}) ppm	Sodium (Na^{++}) ppm	Potassium (K^{+}) ppm	Lithium (Li^{+}) ppm	Fluoride (F^{-}) ppm	Iodide (I^{-}) ppm	Phosphate (PO_4^{--}) ppm	Silica (SiO_2) ppm
1.	Andrasi	Spring	29	6	41	2	nil	0.10	nil	2	3.8
2.	Ball Bala	"	43	11	65	3.1	nil	nil	0.0022	1.6	1.2
3.	Baffa Eidgah	"	46	14	84	2.3	nil	1.1	0.0012	nil	0.5
4.	Bagrian	"	27	4	51	1.4	2.3	0.2	0.003	0.5	1
5.	Balakot	"	29	14	30	1.2	nil	0.2	0.001	1.4	4.2
6.	Banda Sinjlian	"	109	17	125	4.6	0.2	nil	0.0013	3	2
7.	Bandi Chamyali	"	27	3	20	1.2	nil	1	nil	0.3	0.5
8.	Bandi Mera	"	43	9	16	1	0.9	nil	0.0004	nil	0.9
9.	Ban Khad	"	37	10	21	1.6	1	0.6	nil	0.5	1.5
10.	Bara Gali	"	61	10	38	0.8	nil	0. 9	0.003	3	0.8
11	Batagram	"	74	20	71	3	nil	0.1	nil	2.1	1.3
12.	Batamori	"	77	22	211	4.4	nil	nil	0.002	1.7	1.5
13.	Chakoli Kuthyala	"	34	4	18	0.7	nil	nil	0.004	nil	0.5
14.	Chamyali	"	37	13	16	1	nil	0.1	0.0008	0.5	0.5
15.	Chatar Plain	"	19	4	92	·2.8	nil	nil	0.002	3.2	2
16.	Choona Kari	"	50	20	51	1.6	0.1	nil	0.001	0.5	0.9
17.	Dadar	"	35	6	28	1	nil	0.4	0.0015	1.6	1
18.	Dakhan	"	48	3	42	1.2	nil	nil	nil	2	3
19.	Dobather	"	66	15	85	2	0.4	0.6	0.0005	1.9	3
20.	Garhi Phulgran	"	34	12	48	1.3	nil	nil	0.001	1	1
21.	Geedar Pur	"	21	5	22	1	1.36	0.2	0.003	1.3	1
22.	Ghazi	"	104	8	192	3.2	1.2	0.2	0.004	0.8	0.6
23.	Hassainyan	"	64	.15	76	2.4	0.7	nil	0.0022	2	2.5
24.	Jabori	"	22	8	25	2	1.3	nil	0.002	nil	0.5
25.	Jhangi	"	54	8	201	4.3	0.4	0.5	nil	2	2.2
26.	Jijal	"	44	8	51	2	0.5	0.1	nil	3	0.5
27.	Khaki	"	90	10	38	2	nil	nil	0.0035	0.5	3
28.	Khanpur	"	61	26	148	4.6	0.8	1	0.002	2	0.6
29.	Komila	"	64	13	46	1.8	nil	0.3	nil	0.8	0.3
30.	Lumba Mera	"	14	11	44	1.3	1	0.2	0.001	1	2.6
31.	Lora	"	61	14	53	2.1	1.3	0.6	nil	4	2
32.	Mahandri	"	36	6	19	0.9	nil	0.2	nil	0.7	1.5
33.	Malacha Kiala	"	50	5	29	2.1	nil	0.4	0.0008	3.5	2.6
34.	Mandian	"	96	23	176	6	0.5	nil	0.004	1	3.2
35.	Mandian	"	37	7	153	4.6	0.7	0.5	0.0026	2.8	2.5
36.	Mochi Kot	"	18	7	24	1	1.3	0.7	0.0012	4.2	2
37.	Mohanyan	"	56	13	32	1.1	2.3	0.6	0.0024	1.6	3
38.	Mohanyan	"	38	12	49	2. 7	2.1	nil	0.0015	2	4
39.	Nathiagali	"	78	2	25	0.8	nil	nil	nil	2	0.8
40.	Nawan Shehr	"	61	13	72	2.3	0.5	0.2	0.0005	0.9	1.6
41.	Nizami Mohallah (Atd)	"	46	11	54	2	nil	0.4	0.0023	2.2	2.5
42.	Oghi	"	69	7	81	3	nil	0.6	nil	nil	0.3
43.	Sachan	"	18	5	25	0.8	nil	nil	0.0008	3.2	2.5
44.	Sazain	"	58	10	60	3.1	0.7	0.4	0.0009	1.8	1.6
45.	Shergarh	"	90	4	32	1.3	nil	0.2	0.0016	2.6	2.6
46.	Shinkidri	"	43	7	65	2.3	nil	0.2	0.002	1.8	2
47.	Takia Sherwan	"	15	14	147	3.8	0.6	0.25	0.004	3	1.8
48	Jhandiani	"	61	6	20	2	nil	nil	0.0009	4	3
49.	Tumbah	"	38	11	29	1	nil	0.1	nil	1.4	3
50.	Ziarat Kahoo	"	12	10	37	1.2	1.2	0.3	0.001	3.8	2

Table II

S.No.	Place	Source	Calcium (Ca ++) ppm	Magnesium (Mg ++) ppm	Sodium (Na ++) ppm	Potassium (K +) ppm	Lithium (Li +) ppm	Fluoride (F^-) ppm	Iodide (I^-) ppm	Phosphate ($PO4^{--}$) ppm	Silica (SiO2) ppm
1.	Baffa Kalan.	Well	69	35	128	3.6	1.25	0.3	0.003	1.5	1
2.	Baffa Khurd.	"	67	47	201	5	nil	0.7	0.0026	2	2
3.	Batal.	"	53	15	29	2	nil	nil	0.0015	1.5	0.8
4.	Chitti Dheri.	"	99	24	63	1.6	0.6	1	0.0018	2	3.2
5.	Dharyal.	"	69	16	25	1.4	nil	nil	0.002	nil	1.6
6,	Dhodyal.	"	56	18	77	2.1	nil	0.4	0.0085	0.6	1.5
7.	Hadobandi.	"	219	178	310	12	0.5	1	0.008	5.8	3.5
8.	Haripur.	"	62	9	107	2.6	nil	0.25	0.0035	1	0.5
9.	Ichrian.	"	43	32	40	1.4	1.2	nil	0.003	0.5	1
10.	Jabri.	"	61	22	20	1.2	1	nil	nil	2	0.8
11.	Jhangi.	"	29	5	143	2.8	nil	0.3	0.001	3	2
12.	Jhangi Syedain.	"	74	12	89	2	nil	1.2	nil	1.4	1.8
13.	Jinnahabad.	"	56	29	55	1.8	0.25	nil	0.001	3	1
14.	Kotly Bala.	"	54	27	23	1.7	nil	0.4	nil	2	0.7
15.	Lumba Mera.	"	58	9	28	0.9	nil	nil	0.0012	2	1
16.	Mandian	"	115	8	87	3.4	0.6	nil	0.002	0.5	0.5
17.	–do–	"	38	8	53	1.2	nil	0.4	nil	2.5	3.2
18.	–do–	"	80	10	36	2	nil	nil	0.001	2.5	0.5
19.	Nawan Shehr.	"	163	13	93	2.4	1	0.3	0.0006	4	3
20.	Oghi.	"	40	17	56	2.3	1.2	0.5	0.0012	0.6	3.6
21.	Qalandarabad.	"	62	19	53	1.6	nil	nil	0.0008	3.2	2.5
22.	Samesar.	"	22	2	46	1.8	0.8	nil	0.001	2.5	2.8
23.	Shinkari.	"	118	46	215	8	0.6	0.8	0.0035	1.6	1.5
24.	–do–	"	69	19	188	6.2	1.6	0.4	0.0024	nil	1.4
25.	Sikandarabad.	"	75	12	38	1.6	nil	0.6	0.0003	1	1.8
26.	Srae Salah.	"	24	13	120	3	nil	0.6	0.002	0.8	2
27.	Ziarat Kahoo.	"	69	11	49	1.6	nil	nil	nil	2	1.5

Table III

S.No.	Place	Source	Calcium (Ca ++) ppm	Magnesium (Mg ++) ppm	Sodium (Na +) ppm	Potassium (K +) ppm	Lithium (Li +) ppm	Fluoride (F^-) ppm	Iodide (I^-) ppm	Phosphate ($PO4^{--}$) ppm	Silica (SiO2) ppm
1.	Bandi Mera.	Tap	75	4	23	0.9	nil	nil	0.003	1.4	2.3
2.	Data.	"	42	3	52	2	nil	0.25	0.004	2	3
3.	Dehri.	"	16	6	30	0.8	0.5	nil	0.001	1.2	1
4.	Havelian.	"	38	20	75	1.5	1	1.3	0.0015	0.8	1.6
5.	Jinnahabad.	"	82	12	70	2.4	0.9	nil	nil	2	1.5
6.	Kunj Jadeed.	"	82	22	145	3.2	nil	0.4	0.0006	1.5	0.5
7.	–do–	"	69	12	113	2.2	nil	0.5	0.0005	2	1
8.	Malikpura (Upper).	"	58	25	35	1	nil	nil	0.0012	0.5	2
9.	Mandian.	"	67	7	95	2.7	nil	nil	0.0005	1.5	2.6
10.	–do–	"	61	27	64	2	0.4	0.25	0.0008	2.3	1.8
11.	–do–	"	45	6	38	1.3	nil	nil	0.0013	0.6	2.5
12.	Patan.	"	64	5	28	1	nil	0.5	0.0005	2	3

Table IV

S.No.	Place	Source	Calcium (Ca ++) ppm	Magnesium (Mg ++) ppm	Sodium (Na ++) ppm	Potassium (K +) ppm	Lithium (Li +) ppm	Fluoride (F⁻) ppm	Iodide (I⁻) ppm	Phosphate (PO4⁻⁻) ppm	Silica (SiO2) ppm
1.	Bhasha.	Nala	35	5	38	2.1	nil	0.25	0.001	2	3
2.	Darband.	Lake	32	15	65	2.4	1.3	1	0.0053	4	1.8
3.	Dasoo	Nala	36	3	20	1	nil	nil	0.0003	2	2.4
4.	Dobair.	"	31	5	41	1.4	1	0.4	0.0005	1.6	2
5.	Harband.	"	34	9	24	0.9	nil	0.2	0.0008	0.9	1.2
6.	Keyal	"	34	12	32	3.2	nil	nil	nil	0.5	0.8
7.	Mandraza.	"	48	10	36	2.2	0.8	nil	nil	3	2
8.	Shatyal	"	56	7	22	1.5	nil	0.2	0.001	1.5	1.6
9.	Shoori.	"	21	15	20	2.6	nil	nil	0.0005	2	2.2
10.	Sumar.	"	44	12	18	1.4	0.6	0.3	0.0003	1.6	2.1
11.	Thakot.	River	51	13	40	1.6	nil	0.25	0.0008	4.2	2.6

The results of chemical analysis are summarized below.

1. SPRINGS: Fifty samples of spring water were analysed. The mean values for calcium, magnesium, sodium and potassium were found to be 48.9 ppm, 10.3 ppm, 63.6 ppm and 2.14 ppm respectively. Lithium was absent in 26 samples and the mean value for the remaining 24 samples was 0.47 ppm. Fluorides and iodides were absent in 17 and 13 samples respectively. In rest of the samples the average values for fluoride and iodide were 0.27 ppm and 0.00 14 ppm respectively. Phosphate and silica averaged to 1.7 ppm and 1.75 ppm respectively.

2. WELLS: Twenty seven samples were analysed from the wells of various depths. The average concentrations of calcium, magnesium, sodium and potassium were found to be 72 ppm, 24.3 ppm, 87.9 ppm and 2.86 ppm respectively. Fifteen samples were free from lithium, 11 samples from fluoride and 5 samples from iodide. Among the remaining samples, the average lithium content was found to be 0.4 ppm, fluoride 0.34 ppm and iodide 0.002 ppm. The mean value for phosphate and silica appeared to be 1.83 ppm and 1.73 ppm respectively.

3. TAPS: Fifteen water samples were analysed from taps. The mean concentrations of calcium, magnesium, sodium and potassium were detected to be 58 ppm, 12.4 ppm, 64 ppm and 1.75 ppm respectively. Lithium was found nil in 8 samples, fluoride in 6 samples and iodide in one sample. In rest of the samples the mean figure for lithium was 0.23 ppm, for fluoride 0.26 ppm and for iodide 0.0012 ppm. The average values for phosphate and silica were found to be 1.48 ppm and 1.9 ppm respectively.

4. STREAMS (NALAS): Eleven samples were analysed which included one sample from river and one from lake. The average figures for calcium, magnesium, sodium and potassium were found to be 38.4 ppm, 9.6 ppm, 32.4 ppm and 1.77 ppm respectively. Lithium was found absent in 7 sathples, fluoride in 4 samples and iodide in 2 samples. Among the remaining samples the mean values for lithium, fluoride and iodide were worked out to be 034 ppm, 0.24ppm and 0.0011 ppm respectively. The average for phosphate was 2 ppm and that for silica was 1.9 ppm.

DISCUSSION

Mineral constituents of drinking water have not only on its potability and also influence the human health. The individual minerals which have been surveyed in Hazara water supplies are discussed below.

CALCIUM: Some investigators believe that calcium in water can be used by the body as a supplement to the calcium. in the diet. There is also evidence of adverse physiological effects from an insufficiency of calcium in water. Urovsk disease, a severe type of rickets, occurs in regions where the concentration of calcium in drinking water is low[5]. An inverse correlation between the calcium content of waters and cardiovascular diseases has been reported; i.e., high calcium is associated with a low incidence of heart attacks[6]. The maximum permissible level for calcium is 200 ppm[3]. In our, study, only one sample from well (Hadobandi) containing 219 ppm calcium, exceeded that limit. The rest of the samples were within the normal range.

MAGNESIUM: At high concentrations, magnesium may cause undesirable taste and gastrointestinal irritation, particularly in new users. The upper limit for magnesium is 30 ppm where water contains more than 250 ppm sulphate. But if sulphate is less than 250 ppm, then magnesium is tolerable upto 150 ppm[3]. In our survey only one sample (Hadobandi) containing 178 ppm, magnesium exceeded the upper limit rendering the water unfit for drinking.

SODIUM: It has been reported that neonates fed on fresh cow's milk (which contains 580 ppm sodium as compared to human breast milk containing 150 ppm sodium) are at considerable risk of hypernatraemia when they become dehydrated. The low concentrating power of immature kidneys prevents excretion of sufficient sodium to maintain equilibrium. It has been suggested that hypernatraemia might be an important contributory factor in post-neonatal mortality and in sudden infant death syndrome[7]. In drinking water, excess of sodium may be harmful to persons suffering from cardiac, renal and circulatory diseases and as much as 200 ppm sodium from drinking water may be injurious[5]. In Hazara water supplies, only 5 samples from various sources were found to contain above 200 ppm sodium indicating a possible risk factor. The remaining water samples were satisfactory in this respect.

POTASSIUM: Potassium is an essential constituent of intracellular fluid and it is also important in sodium—potassium balance. But excessive quantity of potassium in water acts as cathartic. In our survey, all of the' samples contained less than 12 ppm potassium representing a satisfactory condition.

LITHIUM: The concentration of lithium in drinking water appears to be inversely related to the prevalence of coronary heart disease[8]. It has been recommended that lithium in water for drinking and cooking purposes should not exceed 5 ppm[5]. Hazara water supplies were found to be poor in lithium contents. Fifty six samples contained no lithium while the rest contained less than 2.3 ppm lithium indicative of a desirable concentration.

FLUORIDE: Effect of fluoride on tooth enamel is reflected in the prevalence of dental caries but in excess this element is extremely harmful. In certain areas, notably in India, high concentrations are accompanied by several skeletal abnormalities. In the Indian Punjab natural waters are known with upto 14 ppm of fluoride. Children in parts of Uttar Pradesh usually exhibit the dental mottling and discolouration commonly associated with excess fluorine intake.[9] It has been reported that 0.8 to 1.5 ppm of fluoride ion in drinking water aids in reduction of dental decay, especially among children[5]. It is therefore suggested either low concentrations of fluoride than permissible levels in excess, both are associated with dental abnormalities. In Hazara water supplies 38 samples were having no fluorides. Dental caries are commonly seen in some parts of Hazara Division among children which may be attributed partly to the absence of fluoride in drinking water. The remaining samples contained 'less than 1.3 ppm fluoride representing normal concentration.

IODIDE: The most important element for human health that is frequently absent from soil is iodine deficiency which may lead to endemic goitre or endemic cretinism. The most notorious goiterous centres of the world are in high mountains: the Pyrenees, Alps, Himalayas and Andes where the terrain has been subjected to flooding or glaciation and leaching of iodine[10]. In the present survey, 21 samples were found free from iodine. Among the rest of 79 samples the maximum iodide was found to be 0.0085 ppm which is stifi lower than the reported safe limit of 0.0086 ppm[11]. The endemic goiter, among the dwellers of the hilly areas of Hazara, is very common, which is clearly indicative of low iodine content in water used for drinking and cooking.

PHOSPHATE: Phosphate may occur in surface or ground waters as a result of leaching from minerals, from agricultural drainage or as one of the stabilized products of the decomposition of organic matter. Excessive phosphate is undesirable in water used for preparing food, as it has a buffering action on the acids of the stomach[5]. Only 7 samples from Hazara waters were found to have no phosphate. The maximum phosphate was detected to be 5.8 ppm. Hence there is no danger from phosphate concentration to the consumers.

SILICA: Until recently, silicon was thought to be an environmental contaminant of human tissue. But some recent studies suggested that silicon plays an essential role in the growth of animals, i.e., rats and chicks[12]. Silicon is found in human body in the forms of hyaluronic acid, chondroitin sulphate and keratin sulphate. There is a trend towards decreasing concentrations with age in the human dermis and aorta. With development of atherosclerosis, the concentration of silicon in the arterial wall decreases[12,13]. It has been reported that people consuming hard water with high silica contents were having lower rate of heart disease as compared to those consuming water with low silica content[10,14]. In our survey, all of the water samples contained silica. The maximum concentration was found to be 4.2 ppm. So all water samples may be considered satisfactory in this respect.

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