A Study to Evaluate Therapeutic properties of Minerals of Manghopir Hot Spring, Karachi

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(Received 24th May 2008, accepted in revised form 29th September 2008)

Summary: European balneologists have extensively studied the therapeutic value of mineral water. Mineral springs with different mineral contents are recommended for various therapeutic uses. People have been using geothermal water for bathing and good health for many thousands of years. A mineral hot spring has greater than 1000 mg/L (ppm) of naturally dissolved solids. Hot mineral spring water contains elements like calcium, magnesium, sodium, potassium as sulphates, bi-carbonates and chlorides, which are used externally to cure many diseases. Manghopir spring contain 38-84 mg/L calcium, 29-56 mg/L magnesium, 388-555 mg/L sodium, 411-599 mg/L chloride,186-442 mg/L sulphate, 10-25 mg/L potassium, and 1509-2188 mg/L total dissolved solids while the pH was in the range of 7.2-7.8. The temperature of Manghopir Euthermal hot spring remains constant ranging between 40 to 47 °C.

Introduction

Mineral waters are natural solutions formed under specific geological conditions and are characterized by chemico-physical dynamism. This is a poorly defined concept but generally means that spring water looses most of its ethereal properties when far removed from the source. Attempts to prepare artificial mineral waters have failed because of the absence of related biological activities [1]. People have used geothermal water and mineral water for bathing and their health for many thousand of years. In Japan there are over 2500 hot spring that are used by over 150 million visitors every year.

Some of these international usages have been documented by various authors [2-5]. Several reports have appeared on this subject, documenting these facilities and their use. In the case of the resorts, two books are available [6-9]. In Newzealand, North America and other areas have used hot spring for cooking and bathing. The Romans used geothermal water to treat eye and skin diseases. In Europe, natural hot spring has been very popular health attraction. Japan is considered as world's leader in Balneology. Other countries include USA, Mexico and New Zealand. Based on archeological finds in Asia, mineral water has been used for bathing since the Bronze Age, about 5000 years ago. Many hot springs have been used in connection with religious rites in Egypt and by the Jews of the Middle East [10].

There are over 80 essential nutrients and minerals in hot mineral water and it is believed that over 7,000 enzymatic processes are involved in the human body's metabolism requiring both minerals and trace elements. Common elements found in these curative waters are said to have therapeutic properties. Balneology, the practice of using natural mineral water for the treatment and cure of diseases, also have a long history. It is the scientific study of the therapeutic benefits of naturally occurring mineral water. This science is not very well known and is even less seldom in practice. Balneotherapy (spa therapy or mineral baths) for patients with arthritis is one of the oldest forms of therapy. One of the aims of balneotherapy is to soothe the pain, improve joint motion and as a consequence to relieve patient suffering and make them feel well [11].

In Pakistan, a number of natural springs are reported from district Dadu, Karachi [12] and other parts of country. The therapeutic importance of elements is not known except sulphur which is considered as cure for skin therapy [13]. Many publications have been documented but therapeutic properties of minerals has not yet been discussed [12-

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14]. Pithawala (1938) described that the spring have some curative effects of sulphur for skin diseases [14].

The aim of present study is to evaluate the therapeutic properties of minerals present in hot spring of Manghopir because not only sulphur, all other minerals play very important role in the cure of many diseases. Manghopir hot spring is located about 1.3 Km, north of Karachi at the base of Hallar mountainous range. These are indicated in sheet No: 35 P/11Lat. 24.59'E and 67.06' above sea level. It is abundant in therapeutic sources and has been identified as amongst the best in the world. It is a geothermally heated mineral water spring having temperature above 108 °F (42 °C).The direct volcanic activity plays a great role in the process of the hot spring formation. Not only sulphur, Manghopir hot spring contains calcium, magnesium, sodium, potassium, chloride, sulphate and bicarbonate which are very important in the cure of many diseases. The movement of minerals into the body as the result of mineral water therapy is dependent upon the fat/water solubility due to the structure of the skin membrane. The movement of water into and out of the body during mineral water therapy is dependent upon the osmolality of the bath and the fluid condition of the individual. Depending upon the osmolality of the bath, water is either adsorbed into the body or pulled from the body. Mineral adsorption through hot springs soaking is extremely small and the amount adsorbed into the body is concentration dependent and varies depending on the mineral and its chemical form. Medical balneotherapists have noted that even minute amounts of therapeutic minerals adsorbed into the body through skin have a significant therapeutic value [15].

In short the osmotic qualities, the mineral concentration, the pH level and the mineral form affect the transdermal carrier effects of any mineral waters, as well the fluid conditions of the individual soaking [16]. The chemical effects are related to the minerals and other substances in the water which are transferred to the skin and bloodstream through osmosis.

The physical effects are due to the water temperature, which helps to dilate the skin, thus improving oxygen flow in the tissues that are being treated. The heat also increases the flow of natural sedating substances in the body and muscle relaxation. The mineral concentration and chemical and physical effects create of a sense of wellbeing [17].

Various authors have investigated the therapeutic effects of thermal waters on diseases characterized by an impairment of the immune system, *i.e.* eczema, psoriasis and atopic dermatitis. Hot springs water can increase metabolism, accelerate healing, soothe muscles, improve blood circulation and detoxify the body's lymphatic system. Soaking in the hot springs waters allow minerals to pass through your skin then absorbed and utilized by body cells. This can fight the effects and symptoms of fatigue, insomnia, edema, poor micro-circulation, repressed immune system and even arthritis [18].

Results and Discussion

Ground water containing mineral contents within limit of drinking water standards *i.e.* WHO and PSQCA use as drinking water but if it contains minerals above these standards and temperature above 40 °C then it is consider as hot mineral spring (Figs. 1 and 2). Two primary areas of benefit derive from taking bath in a mineral spring are the mineral contents and temperature of the water *i.e.* above 42 °C [19]. According to Balneologist, Manghopir Hot Spring is classified as true mineral spring, because it has dissolved solids measuring over 2000 mg/L (Table-1A). It is high sulfate alkaline hot spring, with pH level between 7.2-7.8 (Tables-1A, 1B, 2A, 2b). The alkalinity is primarily the result of the potassium, calcium, magnesium and sodium ions. Bathing in hot spring water containing calcium and magnesium in vital for growth, helps maintain bones and in principle curer for diseases of the veins, bronchial infections, neuritis, sciatica, arthritis and menstrual cramps [16]. Magnesium in hot spring converts blood sugar to energy and promotes healthy skin [16]. It contains 38 to 84 mg/L calcium and 29 to 56 mg/L magnesium. Sodium and potassium gives the body fluids, composition and stability. Manghopir Hot Spring contains 388 to 555 mg/L sodium (Tables-1A, 2A). Potassium assists in the normalization of heart rythms, assists in reducing high blood pressure to eliminate body toxins and promotes healthy skin [19]. Manghopir hot spring contains 10 mg/L to 25 mg/L potassium (See Table-1A, 2A, 3A). Hot Spring rich in sulphates (*i.e.* Sulphur compounds) have far

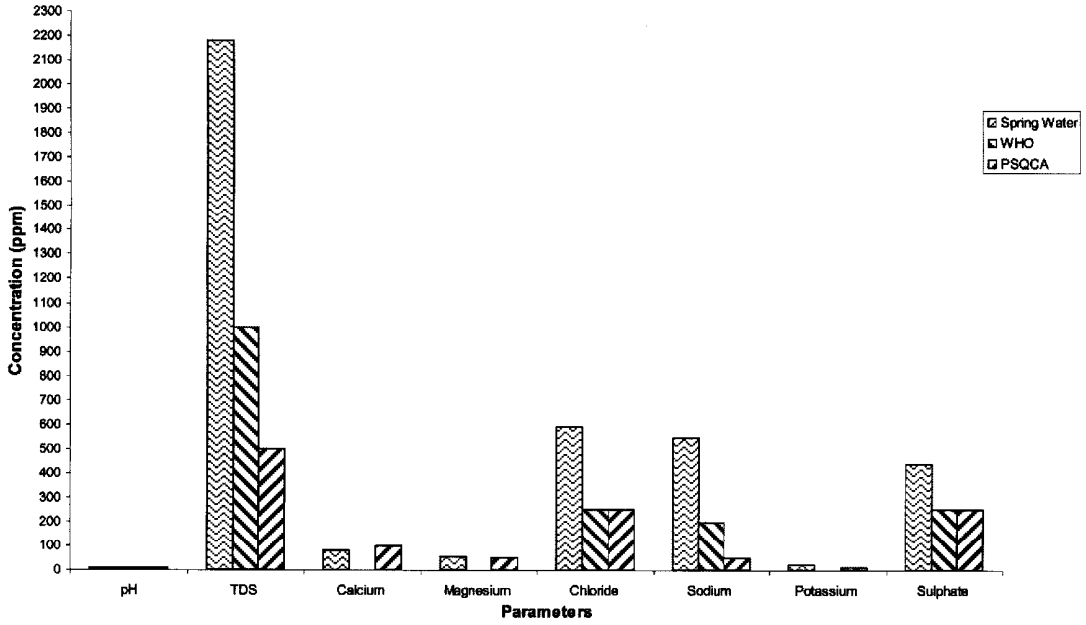

Fig. 1: Comparison of spring water of Manghopir with WHO and PSQCA standards.

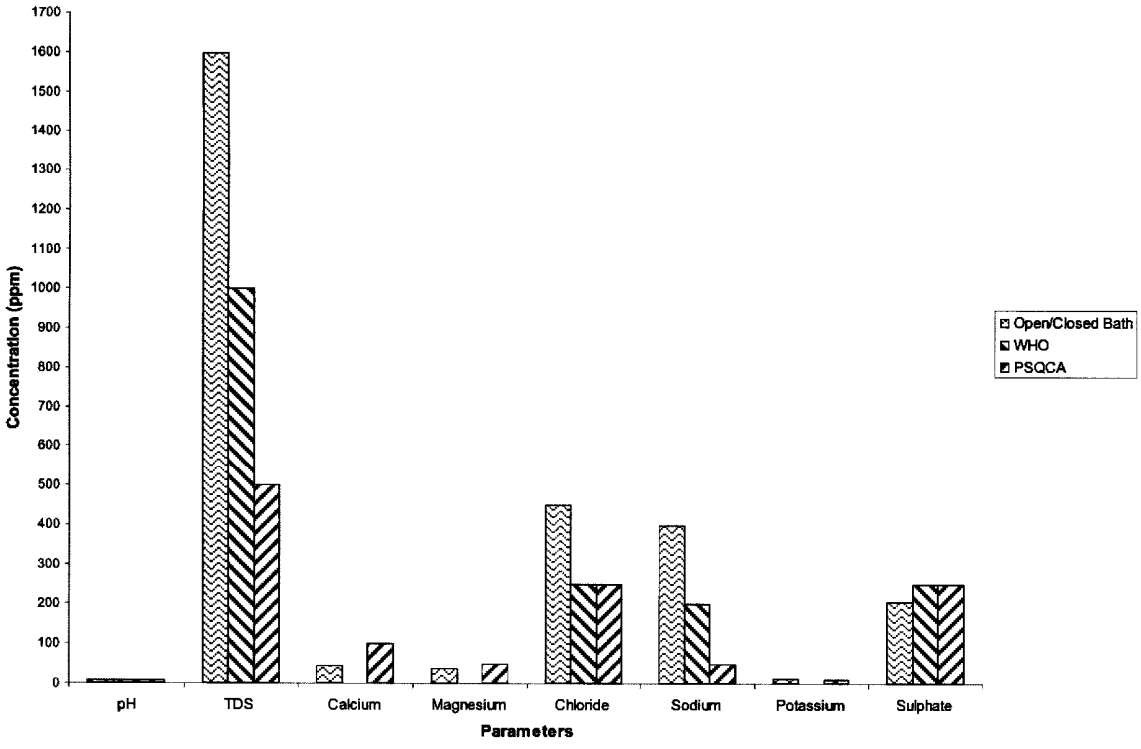

Fig. 2: Comparison of open/closed bath water with WHO and PSQCA standards.

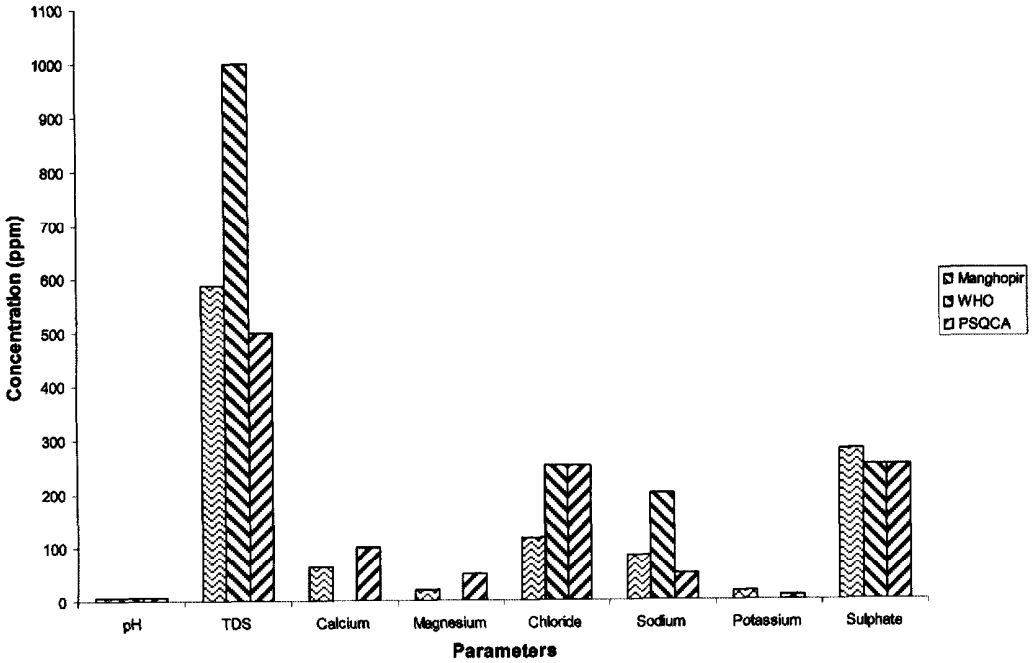

Fig. 3: Comparison of drinking water of Manghopir with WHO and PSQCA standards.

Table-1A: Analysis of Manghopir Hot Spring.

Sample ID	pH	TDS (ppm)	Temp. of Air (°C)	Temp. of water (°C)	Calcium (ppm)	Magnesium (ppm)	Chloride (ppm)	Sodium (ppm)	Potassium (ppm)	Sulphate (ppm)	Bicarbonate (ppm)	Alkalinity (ppm)
Spring 1	7.5	2180	34	47	80	56	584	555	23	437	395	342
Spring 2	7.5	2182	34	47	80	56	584	545	21	437	395	346
Spring 3	7.2	2184	34	47	84	56	592	547	25	440	440	347
Spring 4	7.6	2188	34	47	84	56	599	549	25	442	444	344
Spring 5	7.5	2183	34	47	84	56	590	544	22	439	400	345

Table-1B: Statistics.

Sample ID	pH	TDS (ppm)	Temp. of Air (°C)	Temp. of water (°C)	Calcium (ppm)	Magnesium (ppm)	Chloride (ppm)	Sodium (ppm)	Potassium (ppm)	Sulphate (ppm)	Bicarbonate (ppm)	Alkalinity (ppm)
Mean	7.46	2183.4	34	47	82.4	56	589.8	548	23.2	439	414.8	344.8
Mode	7.5	N/A	34	47	84	56	584	N/A	25	437	395	N/A
Median	7.5	2183	34	47	84	56	590	547	23	439	400	345
Maximum	7.6	2188	34	47	84	56	599	555	25	442	444	347
Minimum	7.2	2180	34	47	80	56	584	544	21	437	395	342
Std. dev	0.151	2.966	0	0	2.190	0	6.260	4.358	1.788	2.121	24.953	1.923

reduced "sulfur" effect as compared to sulphur-rich springs. Such waters are often prescribed internally for lever and gastrointestine condition, as well as for some respiratory condition with inhalation therapy. The effect of sulfur rich mineral springs in the world have been frequently investigated, as sulpur baths have been used successfully in immuno-mediated skin conditions *i.e.,* contact dermatitis, soriasis and atopic dermatitis. It has been suggested recently that the active principle of sulphorous mineral water could play a role in immune regulation in the skin [20]. Manghopir hot spring contains, 188 mg/L to 442 mg/L sulfate (Tables-1, 2A). In addition to the value of the trace minerals found in most hot springs and the stimulating benefits of highly mineralized waters, bathing in bicarbonate water assists the opening of peripheral blood vessels and helps to improve the circulation to the body's extremities [20]. Some researchers believe that bicarbonate bath also assists cardiovascular disease and nervous system imbalances. Mangopir hot spring contains 354-444 mg/L bicarbonate (Tables-1A, 2A). European Balneotherapists also utilized biodegradable waters for bathing to address hypertension and mild

Table-2A: Analysis of Open / Closed baths of Mangophir Hot Spring.

Sample ID	pH	TDS (ppm)	Temp. of Air (°C)	Temp. of water (°C)	Calcium (ppm)	Magnesium (ppm)	Chloride (ppm)	Sodium (ppm)	Potassium (ppm)	Sulphate (ppm)	Bicarbonate (ppm)	Alkalinity (ppm)
Closed bath 1	7.2	1812	34	44	56	45	450	400	18	272	365	310
Closed bath 2	7.2	1818	34	45	54	49	516	420	15	227	368	302
Closed bath 3	7.2	1809	34	45	54	46	518	418	14	229	354	290
Open bath 1	7.4	1524	34	43	40	40	431	388	11	195	371	304
Open bath 2	7.6	1509	34	42	38	34	423	388	12	188	375	307
Open bath 3	7.8	1512	34	44	39	33	411	389	11	186	369	302
Open bath 4	7.7	1523	34	42	42	29	439	394	11	194	374	306
Open bath 5	7.8	1520	34	42	46	30	432	395	13	193	362	313
Open bath 6	7.6	1511	34	43	42	33	439	400	13	196	371	304
Open bath 7	7.6	1514	34	43	42	32	432	392	12	189	361	325
Open bath 8	7.7	1512	34	40	42	29	439	391	10	190	371	306

Table-2B: Statistics.

Statistics	pH	TDS (ppm)	Temp. of Air (°C)	Temp. of water (°C)	Calcium (ppm)	Magnesium (ppm)	Chloride (ppm)	Sodium (ppm)	Potassium (ppm)	Sulphate (ppm)	Bicarbonate (ppm)	Alkalinity (ppm)
Mean	7.52	1596.727	34	43	45	36.4	448.2	397.7	12.727	205.363	367.4	306.3
Mode	7.2	1512	34	43	42	33	439	400	11	N/A	371	302
Median	7.6	1520	34	43	42	33	439	3945	12	194	369	306
Maximum	7.8	1818	34	45	56	49	518	420	18	277	375	325
Minimum	7.2	1509	34	40	38	29	411	388	10	186	354	290
Std. dev	0.237	139.004	0	1.483	1.483	7.324	35.448	11.323	2.284	26.691	6.313	8.4981

atherosclerosis. For these conditions, tepid to warm water bath are utilized (32-37 °C).

Not every one should utilize high temperature hot spring for therapeutic uses. The state of one's metabolism and presence of medical conditions is the determining factor when considering the safest and health water temperature to bath in. According to these facts, Manghopir Hot Spring temperature is very much helpful for the cure of many diseases. European medical doctors have conducted research into thermal therapy, and found that due to thermal therapy, hydrostatic pressure in the body increases leading to increased blood circulation and cell oxygenation and the elimination system of the body are thus stimulated, improving the body capacity to detoxify and the body metabolism is stimulated [16]. This also results to improve digestion. 3-4 weeks of regular thermal bathing can assist in the normalization of endocrine glands and automatic nervous system.

All these properties present in hot spring water of Manghopir shows that it is a complete therapeutic spring. There is a difference in concentration of minerals in sample collect from open and closed bath from Hot spring water (Table-2A). This might be due to contamination in pipe lines through which it comes. Analysis of drinking water shows that there is no correlation between Manghopir Hot Spring water and drinking water (Table-3A) and also it shows that it is fit for human consumption. Statistics of results are given in Tables-1B, 2B, 3B.

Experimental

Sampling

1.5 Liter clean polythene screw capped bottles were used to collect the sample. Each bottle was washed several times with plenty of tap water, then rinsed with sample, cooled to room temperature, recapped and labelled before collection of sample.

Table-3A: Analysis of Drinking Water of Manghopir.

Sample ID	pH	TDS (ppm)	Temp. of Air (°C)	Temp. of water (°C)	Calcium (ppm)	Magnesium (ppm)	Chloride (ppm)	Sodium (ppm)	Potassium (ppm)	Sulphate (ppm)	Bicarbonate (ppm)	Alkalinity (ppm)
DW-1	7.4	572	32	30	60	18	112	85	23	437	395	342
DW-2	7.4	579	32	30	62	18	113	88	21	437	395	346
DW-3	7.5	568	32	30	61	19	112	82	25	440	40	347
DW-4	7.6	611	32	30	69	21	121	80	18	272	365	310
DW-5	7.6	607	32	30	66	24	117	84	15	227	368	302
DW-6	7.5	594	32	30	64	21	120	84	14	229	354	290
DW-7	7.5	580	32	30	66	18	121	86	11	195	371	304
DW-8	7.5	584	32	30	63	18	114	83	12	188	375	307
DW-9	7.6	600	32	30	69	25	120	85	11	186	369	302
DW-10	7.5	588	32	30	65	21	122	83	11	194	374	306

Table-3B: Statistics.

Statistics	pH	TDS (ppm)	Temp. of Air (°C)	Temp. of water (°C)	Calcium (ppm)	Magnesium (ppm)	Chloride (ppm)	Sodium (ppm)	Potassium (ppm)	Sulphate (ppm)	Bicarbonate (ppm)	Alkalinity (ppm)
Mean	7.51	588.3	32	30	64.5	20.3	117.2	84	16.1	280.5	370.6	315.6
Mode	7.5	NA	32	30	69.0	18	112	85	11	437	395	302
Median	7.5	586	32	30	64.5	20	118.5	84	14.5	228	370	306.5
Maximum	7.6	611	32	30	69.0	25	122	88	25	440	395	347
Minimum	7.4	568	32	30	60.0	18	112	80	11	186	340	290
Std. dev	0.073	14.476	0	0	3.100	2.584	4.077	2.211	5.321	111.699	16.5811	20.98783

All necessary measures were taken during sample filling and also during transport and storage. All the chemicals and reagents were of analytical grade. Before analysis all the glassware was washed with tap water, soaked in 2 % nitric acid for one day then again washed with tap water and finally rinsed with several times with plenty of distilled water. Twenty six samples of water were collected from different sites. Three samples were collected from closed bath in which two from closed bath tap and one from a pond. Eight samples were collected from open bath which are located at different points of Manghopir area. Five samples were collected from main Manghopir spring where hot spring arises. Ten samples of drinking water were collected from different houses of Manghopir area.

Chemical Analysis

Chemical analysis was performed in triplicates for each sample and mean values were recorded. pH, temperature of water, temperature of air and conductivity were recorded on sampling site by using digital pH and conductivity meter JENWAY/E.U/430.PH/cad/portable/02162. Sulphate and total dissolved solids were determined gravi-metriccally, chloride by argentometric titration, alkalinity and bicarbonate by acidemetic titration with HCl and calcium and magnesium were determined by complexometyric titration. Sodium and potassium were determined by flame photometer (Corning 410) [21].

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