Chemical investigatin of Bahadur Khel Warcha and Jatta Rock Salt Deposits of Pakistan.

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Abstratct

Salt has played a vital role among the lives of human as saltiness is among the basic tastes of human beings. Over the years salt has been transformed from a common household commodity to essential raw materials. Minor contamination of rock salt is fatal for living systems. Due to its importance complete characterization of table salt is very essential. Present paper focuses the chemical evaluation of unrefined salt samples because unrefined salt is still a preferable choice for consumers in developing countries like Pakistan. During the present research, different salt samples from mining sites of Bahadur Khel, Warcha and Jatta salt mines were collected during a survey to evaluate their Water insoluble matter, Moisture content, Calcium .Magnesium, Sulfate,Potassium and Heavy metal contents by Atomic Absorption spectroscopy. Obtained results were compared with the international standards regarding their maximum permission to living systems such as Codex alimentarius commission, Food and Agriculture (FAO) and World health organization WHO. Obtained results have shown that of all the three salt deposits, Bahadur Khel salt deposits are of low purity.however heavy metal contents were within the legal limits of human consumption.

Key Words: Atomic absorption spectroscopy, Rock salt,Unrefined,moisture content,Heavy metals, Codex alimentarius Commission,FAO,WHO.

1. Introduction

Rock salt which comprises over mainly the Sodium chloride is the essential part of human diet being a food additive, a seasoning and flavoring agent (Cheraghali,2010) .in small quantities, it is inevitable to plants and animals but excess amount may lead to serious health problems(Morris,2008).Nacl provide two major ions ; sodium (Na^{+}) and chloride (Cl^{-}) in addition to traces of Calcium (Ca^{+2}) and Magnesium (Mg^{+2}) and traces of minerals which are essential for the proper functioning of living systems(Gong,1997). In addition of a flavoring and seasoning agent, salt has also many roles to play in living systems. Salt regulate the acid alkali balance of body and serves as an electrolyte in body fluids.

Also rock salt is employed as a raw material for to produce Calcium Chloride, Chlorine gas, Chlorine dioxide, caustic soda and as and antifreeze during the ice cream manufacturing. Contamination of table salt even at very low level lead to serious problems (Heshmati,2014). Heavy metals enter to living systems by exposure to environmental samples like water, salt and food (ZukowskaJ,2008).

In Pakistan both the lake and rock salt deposits are present as one of the largest salt deposits in the world(Alan,1975).which include the Khewra .warcha jatta Bahadure Khel salt deposits. Sea salt is found along the coastal areas of Sindh and Baluchistan.

Bahadur khel salt in District Kohat is Bedded salt which speeded over 12km of length and about 1 km of width. 10.54 billion tons of Rock salt has been estimated by Geological survey of Pakistan (Faruqi,1983).

Warcha salt mines are located 276 km away from south of Islamabad in District Khushab, Punajab.Total resources of Warcha salt mines are reported to be billion tones. Crystals of warcha salt mines range from white to pink and mining is through the method of room and pillars.

Jatta salt mines are located 217 km away from Islamabad and considered from tertiary geological horizon, salt crystals are white, light or grey.Total salt resources are estimated to over few billions of ton.

Levels of heavy metals in salt samples should be check from time to time because of its frequent use in daily life. Usage of unrefined salt has be prohibited by various health agencies(Soylak et al,2008) because it has lesser purity levels.Researchers are on the way for mineral profiling of rock salt deposits of Pakistan(Alan et al,1975).during the present research salt samples were collected from the three mining sites which include Bahadur Khel, Warcha and Jatta salt mines for their complete characterization. Purpose of this research was to evaluate their impact on public health and their utility as industrial raw material.

2. Experimental Work

2.1 Materials and Methods

2.1.1 Collection of samples

Rock salt samples were collected from the mining sites of Warcha, Jatta and Bahadur Khel during a survey. Samples were collected about 20 cm below the mining sites and after collection they were immediately enclosed in the polyethylene bags to be brought into laboratory and in laboratory they were crushed into 60 meshes and transformed into air tight labeled plastic bottles. Samples were opened in the laboratory for their analytical parameters and heavy metal content.

2.1.2 Sample preparation

5 grams of crushed samples were dissolved in 25 mL of water. Resulting solutions were then filtered and filtrate was then diluted to 100mL to analyze further by ASTM.

2.1.3 Acid digestion of samples

Slurry was made by dissolving the 5g of each of salt sample with 10mL HNO_3.after heating below the boiling point for 15 minutes, its volume was made up to 100mLby doubly distilled water. Solution was then heated at 110°C for 30 minutes in order to ensure the complete digestion of samples. Solutions were cooled overnight to be analyzing by Atomic absorption spectrophotometer (Hitachi Z 8000).

3. Results and Discussion

Three mining sites producing the rock salt were selected on the basis of their quality to be evaluated chemically using standard methods. Parameter employed for their chemical evaluation were moisture content, water insoluble matter, calcium, magnesium, sulfate and their heavy metal content. Obtained results of all the analytical parameters are enlisted in table 1 for Bahadur Khel salt mines,table 2 for Warcha Salt mines and table 3 for Jatta salt mines.

In water insoluble matter determined by gravimetric method, bahadur khel salt samples relatively had higher values of 3.4% to 3.5 % as compared to warcha and Jatta salt deposits having water insoluble matter in the range of 0.37% to 1.56 % and 0.69 to 2.31 % respectively.

Sulfate content of all salt samples were also determined by gravimetric method. Sulfate content had range values from 2.13 % to 2.23 for bahadur khel, 0.3% to 0.32% for Warcha and 0.19% to 0.23 for Jatta salt mine salts.

Table Showing Analytical parameters of BahadurKhel salt mines

Sample	**NaCl %**	**Moisture%**	**Ca^{+2}%**	**Mg^{+2} %**	**SO_4^{-2}%**	**water insoluble%**
1	92.02	0.12	1.75	0.16	2.15	3.5
2	93.1	0.13	1.62	0.14	2.21	3.4
3	93.2	0.14	1.44	0.13	2.23	3.4
4	93.1	0.12	1.43	0.12	2.19	3.6
5	92.8	0.11	1.47	0.11	2.2	3.4
6	92.6	0.12	1.49	0.13	2.13	3.3
7	92.3	0.12	1.73	0.8	2.23	3.4

Amount of calcium and magnesium were determined as *Calcium and magnesium* and Calcium only. Magnesium was determined using the method of difference. Calcium in all Bahadur khel salt samples were in the range of 1.43% to 1.75% for warcha salt mines its range was 0.21% to 0.23% while for Jatta salt samples it was 0.43% to 0.52%.Magnesum range from 0.8% to 0.16% , 0.09% to 0.13% and 0.01%

to 0.02 % for Bahadur khel,Warcha and Jatta salt mines respectively. All values of above parameters were in the range set by Codex alimentarius commission.

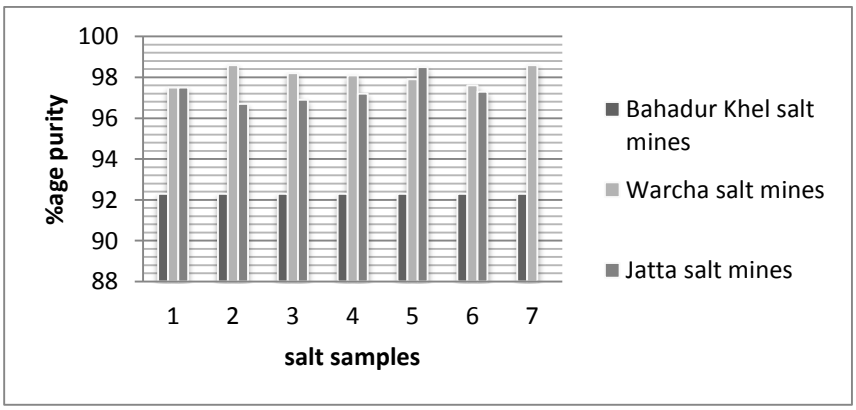
Table2: showing analytical parameters of Warcha salt mines

Sample	NaCl%	water insoluble%	Ca^{+2}%	Mg^{+2} %	SO_4^{-2}%	Moisture%
1	97.5	1.56	0.2	0.1	0.31	0.11
2	98.6	0.47	0.21	0.1	0.3	0.11
3	98.2	0.77	0.22	0.09	0.29	0.12
4	98.1	0.85	0.22	0.1	0.29	0.11
5	97.9	1.02	0.22	0.12	0.3	0.13
6	97.6	1.27	0.23	0.13	0.32	0.14
7	98.6	2.3	0.22	0.12	0.29	0.1

An obtained result has shown that salt from Bahadur Khel has least purity of all samples collected from the mining site figure 1.

Atomic absorption analysis results of heavy metals are enlisted in table 4, 5, and 6 for respective resources.

Graph 1 showing %age purity of salt samples.



A slight variation of these heavy metals above or below the allowed limits can lead to serious metabolic malfunctions as both excess or deficiency of these minerals is critical for living systems(Pandias,1984).

Table 3 showing the analytical parameters of Jatta salt mines.

sample	NaCl%	Water insoluble%	Ca^{+2}%	Mg^{+2}%	SO_4^{-2}%	Moisture
1	97.5	1.57	0.47	0.01	0.23	0.12
2	96.7	2.31	0.52	0.01	0.19	0.11
3	96.9	2.21	0.51	0.01	0.21	0.14
4	97.2	1.86	0.5	0.02	0.23	0.14
5	98.5	0.69	0.47	0.01	0.21	0.13
6	97.3	1.72	0.43	0.02	0.22	0.14

In addition to its role in metabolism and as catalyst, Iron (Fe) is important biologically being the part of various living components such as Heme pigments, myoglobin, and etc(Jacob and Morvood,1974) .Permissible limit for iron in human diet is 50µg/day to 400 µg/day. All the samples had limits below this range.

A slight variation of copper (Cu) in living systems can lead to serious consequences such as nephrotoxic effects (Watson,1993).Dietary requirement for copper is 150 µg/day to 600 µg/day. Obtained results of copper were far below this limit. Manganese finds its utility being important in normal growth and normal reproductive functioning of reproductive organs.

Table 4 Heavy metals in Bahadur Khel salt mines (mg/Kg)

Sample Number	Fe	Zn	Cu	Mn	Cr	Pb	Cd
1	0.61	0.19	0.02	ND	0.29	0.03	ND
2	0.58	0.18	0.03	ND	0.28	ND	ND
3	0.6	0.21	0.04	ND	0.31	0.1	ND
4	0.63	0.22	0.05	0.01	0.3	0.2	ND
5	0.61	0.24	0.06	0.01	0.29	0.21	ND
6	0.62	0.21	0.05	ND	0.28	0.23	ND
7	0.59	0.2	0.05	0.06	0.29	ND	ND

Its deficiency is reason for diabetes, nervous abnormality and arthritis(Underwood,1991).codex food standard allows 2.0 µg/g of lead as the maximum permissible limit set by Codex alimentarius Commission.All the obtained results in present research had values of Lead far below this limit.

Table 5 Heavy metals in Warcha salt mines (mg/Kg)

Sample Number	Fe	Zn	Cu	Mn	Cr	Pb	Cd
1	0.97	0.19	0.03	ND	0.32	0.04	ND
2	0.96	0.21	0.1	0.1	0.28	0.12	ND
3	0.87	0.21	ND	0.04	0.27	ND	ND
4	0.97	0.18	0.12	ND	0.23	ND	ND
5	0.93	0.19	0.11	ND	0.35	ND	ND
6	0.94	0.21	0.12	0.2	0.33	0.12	ND
7	0.99	0.23	ND	0.17	0.32	0.13	ND

Highest value of cadmium in our obtained results of salt samples were0.04 mg/Kg.This value is also far below the values that obtained during the studies of table salt from Egypt,Turkey,Greece (Soylak et al 2008) and Iran(Khaniki et al,2007).

Table 6 heavy metals in Jatta salt mines

Sample Number	Fe	Zn	Cu	Mn	Cr	Pb	Cd
1	1.61	0.24	0.05	0.04	0.41	0.04	ND
2	1.65	0.29	0.2	0.1	0.37	0.07	ND
3	1.58	0.25	0.21	0.05	0.41	0.08	ND
4	1.57	0.24	0.23	0.06	0.45	0.09	ND
5	1.57	0.24	0.21	0.04	0.45	0.09	ND

6	1.54	0.27	0.22	0.07	0.47	0.08	ND
7	1.47	0.26	0.23	0.12	0.41	0.7	ND

4.Conclusions

Chemical investigation of environmental samples is important routinely for to evaluate their role on public health.Bahadur Khel, Warcha and Jatta salt mines had minor contribution in in rock salt production but its chemical evaluation was essential as a little was known about their chemical nature .All the minerals present in these salt samples is within the limits set by standard regarding the Codex and FAO/WHO. Except the BahadurKhel salt mines, a low moisture and sulfate contents implies that they are good raw material for calcium carbonate industry.

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