Determination of Heavy Metals in the Different Samples of Table Salt

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Abstract: Table salt is most widely used food additive around the globe. Any contamination to salt may lead to health hazards and ailments. In this study concentration of heavy metals were determined in different table salt sample. Twelve different salt sample were collected from various localities of Pakistan including all the four provinces. The concentration lead (Pb), Cadmium (Cd), Chromium (Cr), Iron (Fe), Manganese (Mn) and Copper (Cu) were determined by atomic absorption spectroscopy and compared it with Codex Alimentarius commission. The level of Pb, Cd, Cr, Fe, Mn and Cu were in the range of 0.1-2.96 mg/kg, 0.08-1.18 mg/kg,0.02-2.4 mg/kg, 2.5-16.7 mg/kg, 0.1-5.1 mg/kg, 0.6-3.1 mg/kg respectively. In most of the sample the level of toxic metal are within the permissible limits as prescribed by Codex Alimentarius Commission.

Keywords: Heavy Metals, Atomic Absorption Spectroscopy, Codex Alimentarius Comission, Iranian Food standard.

INTRODUCTION

Table salt is the oldest mineral used and discovered by human. Sodium and chlorine are the major components of common salt. It improves the taste of food, and is essential for both the plant and animals only in minute quantities [1]. Halite or common salt chiefly provides sodium and chloride ions. There are some element which are required in little amounts for normal body functioning and are called essential are potassium, magnesium, calcium, iron, zinc, nickel, chromium, cadmium, manganese, copper & cobalt [2]. There are different varieties of common salt which include lake, sea, rock and salt. Lake salt is either obtained from old sea areas or salty water passing over rock salt. It may also be collected by forming lakes in appropriate areas. Sea salt is collected from Aegean region by the evaporation of sea water. Rock salt is present in soil and is formed by the evaporation of inland sea water in hot climatic condition with time. Source salt was collected from river, well and sources [3].

Sodium chloride contains 60.663% chlorine and 39.337% sodium. It is an important ingredient of food in trace amount but causes serious complication in excess amount like hypertension and other diseases [4]. To prevent essential hypertension and chronic diseases, the population NaCl intake should be <5.0 g/day [5]. Salt is very important commodity and gets its significance for its myriad applications, from foods, feeds [6], fertilizers [7], medical uses [8], highway de-icing, to manufacturing of glass, textiles [9] and others. In Pakistan the salt is obtained from rocks and Sea/lakes. Rock salt is the major source of sodium chloride while some salt is collected from coastal areas of Sindh and Balochistan [10]. Sea salt usually show higher content of trace nutrients [11] during the present investigation, different table salt samples were collected from the mining sites as well as well as the local markets (Table **1**) in order to evaluate their heavy metal contents.

MATERIAL AND METHODS

Sampling

The study was conducted on all the major salt deposits of Pakistan. Some of the major deposit are Khewra, which is located in the province of Punjab. Twelve salt samples were collected from the different localities of Pakistan. These include eleven unrefined salt sample and one refined sample. All the samples were obtained with the help of local personals.

Reagents and Solutions

Analytical grade of sodium chloride standard (Merck, Germany) was used for the preparation of calibration curve. Ammonium pyrolidinedithiocarbamate (APDC) and 4-methyl-2-pentanone (MIBK) and all reagent used were analytical grade. All the solutions were prepared in doubly deionized water.

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Table 1: Instrumental Condition for the Measurement of Analyte

Analyte	Wavelength (nm)	Slit width (nm)	Lamp current (mA)
Cu	327	0.1	4
Cr	425	0.1	7
Mn	403.1	0.1	5
Fe	372	0.1	5
Pb	405.8	0.1	5
Cd	326.1	0.1	4

Analysis of Samples

A perkin-Elmer Model AA 200 atomic absorption spectrophotometer having cathode lamp and air acetylene burner were used for the determination of metal ions. A pH meter was used for measuring pH in aqueous phase. The operating parameters as set by manufacturer were given below in the Table **1**.

To 2.0 g of salt sample, 2 mL of HNO_3 and 10 mL HCl were added for digestions of samples to analyze Cu, Pb, Ni, Ag, Mn, Ba, Zn, Cd, Se and Fe. For the determination of Cr, 3 ml of concentrated HNO_3 was added to the sample. Reflux the sample when color of the solution start changing then add 10 ml of HCl. Heat the sample on hot plate and then reduce the volume to 25 ml. Now Cool and filter the solution to remove insoluble material adjust the volume 25/50 and mix. Run the solution on AA-200 Perkin Elmer atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

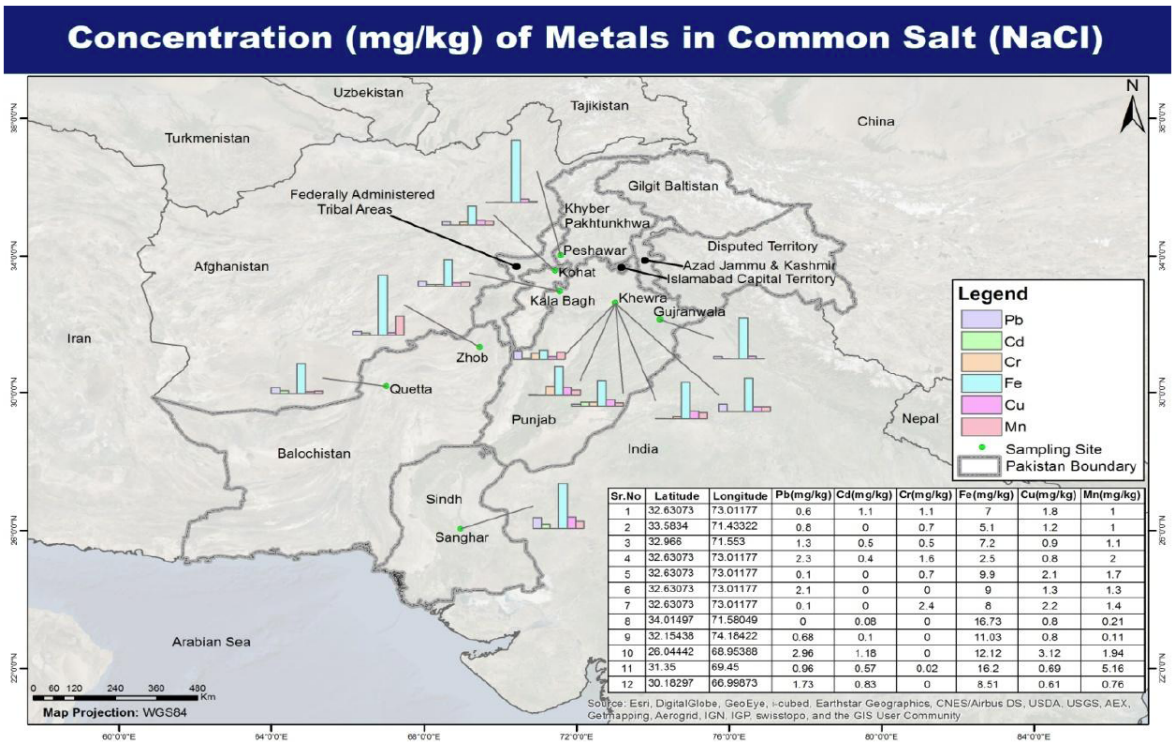
The concentration of heavy metals in twelve different salt sample were determined by air acetylene flame using atomic absorption spectrophotomer. The mean concentration of heavy metals in table salt mentioned in Table **2**.

The mean concentrations of heavy metals in S1 salt sample range from 0.6 to 7 mg/kg. The highest concentration of among them is Fe i.e. 7 mg/kg while the lowest is Pb which is 0.6 mg/kg. Levels of all the metals except Cd have been found within the permissible limits prescribed by Iranian Food Standards and Codex Standards. The content of Cd was greater in the S1 than the permissible limits. The concentration of iron is below the limits as set by health authorities. Iron is essential metal for both the humans and animals. As it is the integral part of hemoglobin to carry out many important processes in living system. Its lower content must be alarming in the sample. Highest concentration of metals in the sample S3 is 7.2 mg/kg while lowest is of Cr which is 0.7 mg/kg. The content of Pb is greater than Iranian food standard but less than codex standard. Heavy metal concentration varies from 0.5 to 7.2 mg/kg.

Among the salt sample analyzed lead concentration was maximum in S10 while minimum in S5 and S7. The maximum concentration of lead was found 2.96

Table 2: Average Concentration in mg/kg of Heavy Metals

Sr. No	Salt sample	Source	Pb	Cd	Fe	Cu	Mn	Cr
1	Khewra Crystal white	Mining site	0.6	1.1	7.2	1.8	1.00	1.1
2	Kohat White	Mining Site	0.8	N.D	5.1	1.2	1	0.7
3	Kalabagh Reddish	Mining Site	1.3	0.5	7.2	0.9	1.1	0.5
4	Khewra Black	Mining Site	2.3	0.4	2.4	0.8	2.0	1.6
5	Khewra Reddish	Mining Site	0.1	N.D	9.9	2.1	1.7	0.7
6	Khewra Pink	Mining Site	2.1	N.D	9.0	1.3	1.3	N.D
7	Khewra White	Mining Site	0.1	N.D	8.2	2.2	1.4	2.4
8	BahadurKhel Reddish	Mining Site	N.D	0.07	16.7	0.8	0.2	N.D
9	Gujranwala White	Local Market	0.6	0.09	11.02	0.8	0.1	N.D
10	Sanghar White	Mining Site	2.96	1.18	12.12	3.18	1.94	N.D
11	Zhob Reddish	Mining Site	0.9	0.57	16.2	0.69	5.16	0.02
12	Quetta White	Local Market	1.73	0.83	8.51	0.61	0.76	N.D



Sr.No	Latitude	Longitude	Pb(mg/kg)	Cd(mg/kg)	Cr(mg/kg)	Fe(mg/kg)	Cu(mg/kg)	Mn(mg/kg)
1	32.63073	73.01177	0.6	1.1	1.1	7	1.8	1
2	33.5834	71.43322	0.8	0	0.7	5.1	1.2	1
3	32.966	71.553	1.3	0.5	0.5	7.2	0.9	1.1
4	32.63073	73.01177	2.3	0.4	1.6	2.5	0.8	2
5	32.63073	73.01177	0.1	0	0.7	9.9	2.1	1.7
6	32.63073	73.01177	2.1	0	0	9	1.3	1.3
7	32.63073	73.01177	0.1	0	2.4	8	2.2	1.4
8	34.01497	71.58049	0	0.08	0	16.73	0.8	0.21
9	32.15438	74.18422	0.68	0.1	0	11.03	0.8	0.11
10	26.04442	68.95388	2.96	1.18	0	12.12	3.12	1.94
11	31.35	69.45	0.96	0.57	0.02	16.2	0.69	5.16
12	30.18297	66.99873	1.73	0.83	0	8.51	0.61	0.76

Figure 1: Map showing different concentration of metals in table salt.

mg/kg and minimum 0.1mg/kg. In S8 lead is below the detection limit. The levels of Pb in different salt samples were in the range of 0.1 to 2.96 mg/kg. In comparison to the result reported by Sharif *et al.* [11] in different salt sample are in the range of 0.02-0.1 mg/kg. Cadmium concentration were in the range of 0.08 to 1.18 mg/kg. Cadmium is non-essential heavy metal and codex allows its concentration in table salt samples to be 0.5 mg/kg [12]. In Tehran Cadmium in different table salt which were separately reported was 0.01-0.4 ug/g, 0.65ug/g and 0.024 µg/g while in Brazil the amount of cadmium in table salt was found in the range of 0.01-0.03 µg/g [13]. Chromium being essential nutrient find its utility in living system. Chromium in previously reported data suggested its concentration to be 0.4 mg/kg by Sharif *et al.* [11]. Obtained results were in the range 0.4 to 2.4 mg/kg. So obtained results showed a higher concentration of chromium. Iron reported by Sharif (2007) was in the range of 0.24-0.62 mg/kg while iron reported by Heshmati *et al*. (2014) in salt sample was 4.1-9.87 mg/kg [14]. The present research suggested that the concentration of iron in the salt sample had higher content of iron. Copper is an essential element having codex limit of 2 mg/kg a slight variation of copper is fatal for public such as nephrotoxic, hepatolentcular degeneration etc. [15]. Manganese due to its essentiality finds its way in having systems as essential component of many enzymes and for metabolism [16]. Five sample out of twelve salt sample were without manganese while remaining salt samples had the concentration from 0.02-5.1 mg/kg. The mean concentration of Mn in different salt sample are in the ranges (0.11-5.16 mg/kg) Therefore the heavy metals measured in the various salt samples can be arranged as follows,

Starting from the highest to the lowest in terms of contamination.

Salt sample S1: Fe > Cu > Cd > Cr>Mn>Pb

Salt sample S2: Fe > Cu >Mn>Pb> Cr > Cd

Salt sample S3: Fe >Pb>Mn> Cu > Cr= Cd

Salt sample S4: Fe >Pb>Mn> Cr > Cu > Cd

Salt sample S5: Fe> Cu>Mn> Cr >Pb>Cd

Salt sample S6: Fe>Pb> Cu=Mn> Cr =Cd

Salt sample S7: Fe > Cr > Cu >Mn>Pb>Cd

Salt sample S8: Fe > Cu >Mn> Cd > Cr =Pb

Salt sample S9: Fe > Cu >Pb>Mn> Cd > Cr

Salt sample S10: Fe> Cu >Pb>Mn> Cd > Cr

Salt sample S11: Fe >Mn>Pb> Cu > Cd > Cr

Salt sample S12: Fe > Pb > Cd >Mn> Cu > Cr

Then finally the arrangement can be deduced as follows;

Fe > Cu>Mn> Cr >Pb>Cd

CONCLUSIONS

In conclusion the level of toxic metals were significantly lower than the permissible limits as prescribed by codex. Iron is essential element and present in highest concentration while cadmium is present in least amount which toxic one. The level of lead was higher than cadmium in the investigated samples. All the salt sample are safe to use and have no hazardous effects.

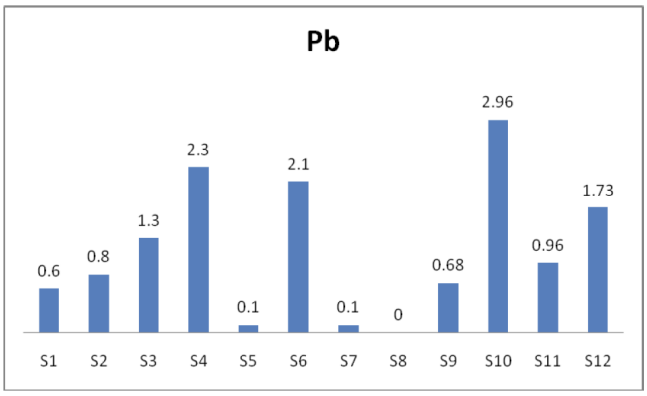


Figure 2: Concentrations of Lead.

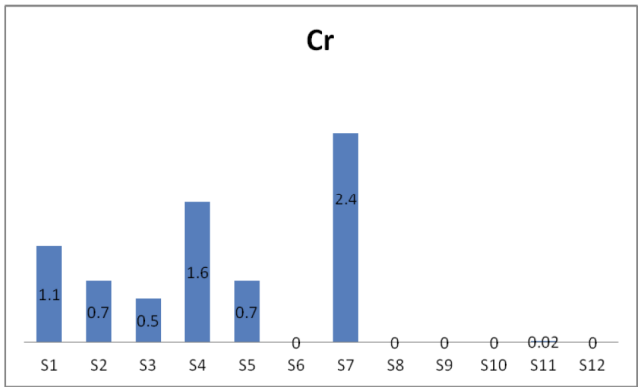


Figure 3: Concentrations of Chromium.

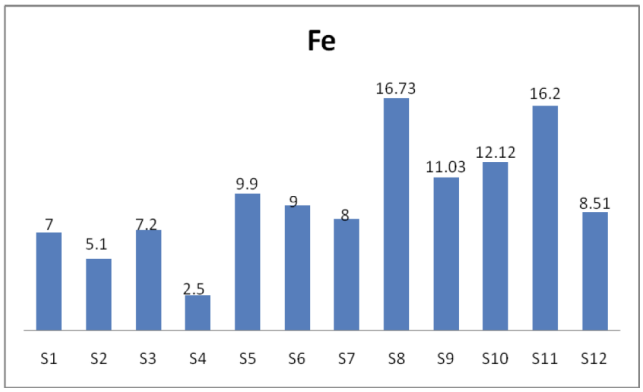


Figure 4: Concentrations of Iron.

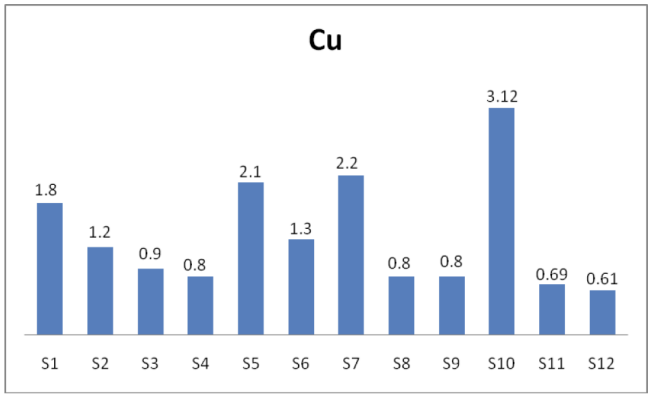


Figure 5: Concentrations of Copper.

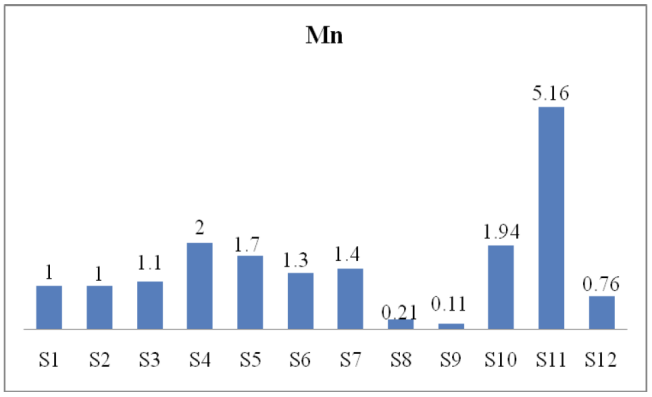


Figure 6: Concentrations of Manganese.

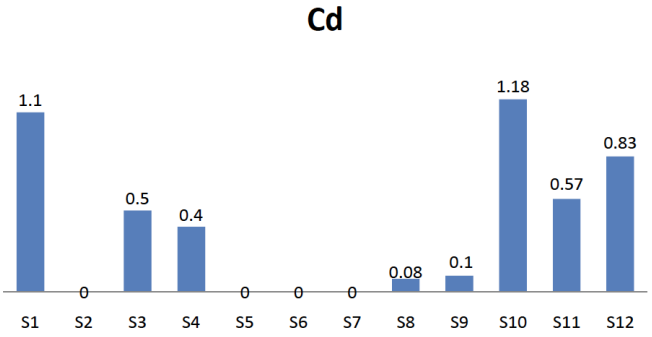


Figure 7: Concentrations of Cadmium.

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