Determination of selected heavy metals and metalloids in different edible salts

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Abstract - The present study investigates the selected heavy metals and metalloids concentration in different type salts available at local market of Raipur. Contents of Cu, Fe and Pb in the analyzed salt samples were found lower than that of recommended values of Codex Standards and Indian Standards. Copper content ranged from 0.005 – 0.035mg/kg, iron content ranged from 0.323 – 1.520 mg/kg and lead ranged from 0.12 – 0.17mg/kg. Lead content in all the samples was within the codex specification of 2.0ug/g of lead content. Potassium content ranged from 55.86 to 19070.8 mg/kg and sodium ranged from 596.82 - 1127.00 mg/kg. The result shows that rock salt can be considered lowest in potassium and sodium concentration in comparison to the other analyzed salt samples, and therefore it's an ideal salt to be used by the persons suggested to take low sodium/ potassium in their diet. On the other hand the excessively higher concentration of potassium in other salt samples is a source of worry and interventional measures need to be put in place to ensure that the salt is properly purified and treated.

Index Terms - metals, metalloids, edible, rock salt, pink salt, iodized salt

I. INTRODUCTION

Salt is a mineral that is mainly composed of sodium chloride. It is an essential part of the diet without which food becomes tasteless. It is required for both plants and animals in small quantities, but harmful when present in excess [1]. The two major component of salt are chloride and sodium ions. Salt comes from two main sources: sea water and mines in land (also known as rock salt). From its underground beds salt may be extracted by mining. According to CODEX standard (2001) [2], food grade salt should be obtained from the sea, the lake underground rock salt deposits or from natural brine. The quality should be on the basis that NaCl should not be less than 97%. Salt, for human consumption is produced in different forms: unrefined salt, refined salt (table salt) and iodized salt which are the most widely used presently, is mainly sodium chloride.

The present study was conducted to investigate the two essential micronutrients and non essential heavy metal concentrations in different edible salts available in Raipur local market. Objective of this study was to know about the sodium, potassium copper & iron nutrients and most toxic element lead concentration. There are various types of salts available in the market, sea/lake salt and rock salt etc. For this purpose, six samples i.e. rock salt, black salt, simple white salt, iodized salt, pink Himalyan salt and unrefined salt were collected from different areas of Raipur and were analyzed for four essential elements (Na, K, Fe, Cu) and non essential heavy metals (Pb). The results were compared with permissible limits of WHO required for normal body functions.

II. MATERIAL AND METHODS

All the standard solutions were prepared from analytical grade compounds of Merck Company. All the glassware used was of Borosil. Prior to all chemical analyses the reagent bottles, beakers, and volumetric flasks were cleaned by soaking overnight in 2N hydrochloric acid, rinsed with distilled water and oven dried at 60oC. Flame Photometer (MODEL 1382) and Atomic Absorption Spectrometer (AA240-Varian) were used for analysis.

A. Sample Collection and preparation

Edible salt samples commercially available were purchased from local grocers in Raipur. The samples were oven dried at 70oC until the samples were completely dry and reached to a stable weight. Afterwards, samples of each salt were powdered separately using glass Mortar and piston.1.0 gm of sample was taken in conical flask. 10ml nitric acid was added with sample and stands it overnight under fume-

hood then heated on Heating Plate at 90-100oC till brown fumes from the samples will disappear and then cool the mixture up to room temperature, diluted up to 100 ml with de-ionized water. The final solution was then filtered through Whatman filter paper (number 42). The clear solution was used for metal quantification.

B. Sample Analysis

Working solutions of 100 ppm was pre-pared from the stock solutions (1000 ppm Merck) of the selected metals and serial dilutions were made from the working solution. The absorbance of the solutions was obtained using AAS at 324.7, 248.3 and 217.0 nm for copper, iron and lead respectively. The calibration graph was plotted and the samples were analyzed for the metal concentration. De-ionized water was used as control.

By dilution of the sodium and potassium stock standards 60, 40 and 20 ppm Na and K standards were prepared. De-ionized water was used as blank. Each salt sample was weighed 1.0 gm and make up to the 100 ml with de-ionized water, mixed and filtered with whatman paper. After calibration of the instrument The blank and standards were aspirated then the sample solution was aspirated and the results were noted by the display.

III. RESULT AND DISCUSSION

Table 1 shows the metal contents obtained from analysis of selected salt samples based on dry weight. Contents of Cu, Fe and Pb, in table refined salt were lower than that of recommended values of Codex Standards and Indian Standards (Table 2).

Copper content obtained from the salt samples ranged from 0.005 – 0.035mg/kg. Siulapwa and Mwambungu (2015) [3] reported copper content in Kaputa (2.22ug/g) and Chibwa (2.32ug/g) salt slightly higher than the maximum codex set standard of 2.0ug/g. WHO also recommended 2.0mg/kg maximum of copper content. Onianwa et al (2001) [4] reported the level of copper in edible salt is 2.04mg/kg that is very high than the present study. Pourgheysari et al (2023) [5] observed the copper level in the studied table salt in the range of 0.654 –

1.08 µg/g. Soylak et al., reported it to be in the range of 0.14 – 0.3 µg/g [6]. A range of 0.7 – 0.8 µg/g was also reported by Narin et al (2003) [7], up to 0.3 µg/g by Peker et al (2007) [8] and in the range of 1.21 – 1.24 µg/g by Khaniki et al (2007) [9]. Copper (Cu) is both, essential and non-essential element. Cu is a micronutrient and is a nutritional component for plants and other living beings required for their growth in small quantities but pose threat to both plant and animal in greater concentrations [10], [6]. It is advisable that salt contains less quantity of this metal or if possible not to contains it at all [8]. Too much copper impairs thyroid activity and the functioning of the liver. At low concentration, copper is essential for human health; however, high levels of these elements are toxic [11], [12].

Iron content ranged from 0.323 – 1.520 mg/kg. According to the codex standards and Indian standard the maximum permitted level of iron in food grade is 10 ug/g and 50 mg/kg. Khanki et al, (2007) [9] reported very high values of iron i.e. 15.3 – 17.8 mg/kg in 60 samples of kitchen salts and table salts. Heshmati et al, (2015) [13] reported 0.689 mg/kg average value of iron in bakery refined and table refined salt samples. The values are in accordance with the present result. Results of Siulapwa and Mwambungu (2015) [3] show that iron content in Kaputa salt (14.98ug/g) were higher than the maximum acceptable level. Nafees et al (2013) [14] studied the edible grade of salts that appeared to be enriched in Fe with the range of 12 – 23 mg/kg. Iron is essential for life and though considered a trace element, diet lacking in iron can contribute to iron deficiency anemia [15] and however, too much iron may be toxic to humans.

Lead content in all the samples analyzed was ranged from 0.12 – 0.17mg/kg. The maximum permitted level of lead in food-grade salt is 2.0µg/g according to the Codex legislation [16]. Lead content in all the samples was within the codex specification of 2.0ug/g of lead content. Our results for lead are much lower than those reported in literature, where lead content has been reported to be in the range of 0.5- 1.64ug/g in refined and unrefined table salt samples from Turkey, Egypt and Greece. However, the content was higher than that the salts (0.03ug/g) reported in Brazil (Soylak et al., 2008) [6]. Toxic elements are fairly widespread in the environment and edible salts may contaminate to some of them. They can enter to human body by ingestion of edible salts. The intake of heavy metals by human through salt ingestion depends on their food habits. Lead is one of the most toxic heavy metals that accumulates in the body and data published in literature indicates that its excessive intake harm

different systems and organs such as central and peripheral nervous system, gastrointestinal tract, muscles, kidneys, and hematopoietic system (Munoz et al.,2011) [17].

Concentration of sodium ranged from 596.82 - 1127.00 mg/kg. The highest concentration of sodium (1127.00 mg/kg) was reported in PHS4 sample followed by IS5 (1029.00 mg/kg), PHS6 (0936.88 mg/kg), WS3 (0893.76mg/kg), BS2 (0870.24 mg/kg) and lowest was reported for RS1 (0596.82 mg/kg). The similar findings were reported by Singh et al, (2009) [18] that rock salt showed lowest potassium among all the selected samples. The presence of a reasonable amount of Na in the human body helps with nerve activity, muscle contraction, and fluid balance. Thus, everyone needs some sodium, but since sodium is found naturally in foods, most people consume more sodium than they need. When kidneys fail to work properly, the extra sodium is not removed from the body. This means that one needs to select the proper use of table salt containing low sodium.

Potassium content ranged from 55.86 to 19070.8mg/kg. RS1salt had very high content of potassium (28.9mg/kg) exceeding the content in other salt samples by far. PHS4 has second highest concentration (22.1 mg/kg) followed by PHS6 (20.4mg/kg), WS3 (15.3mg/kg), BS2 (12.2 mg/kg) and lowest concentration was observed for IS5 (03.3mg/kg). The present results are in accordance with the values observed by Singh et al, (2009) [18] as they also reported very high concentration of potassium in most of the analyzed samples but lowest potassium was reported in rock salt. Lugendo and Bugumba, (2021) [19] also observed concentration of potassium ranged from 804 - 3689 mg/kg. In trace quantities, potassium plays an important role in acid-base regulation, fluid balance, muscle contraction and nerve conduction. Hyperkaleamia is a condition which occurs when there are high levels of potassium in the blood stream. The main symptoms of hyperkalemia include decreased blood pressure, stomach cramps and vomiting.

IV.CONCLUSION

The results showed that in terms of potassium highest potassium was reported in WS3 while lowest were found in RS1. Highest sodium was observed for PHS4 and lowest was reported for RS1. Thus rock salt can be considered lowest in potassium and sodium concentration in comparison to the other analyzed salt samples, and therefore it's an ideal salt to be used by the persons suggested to take low sodium/ potassium in their diet. On the other hand the excessively higher concentration of potassium in other salt samples is a source of worry and interventional measures need to be put in place to ensure that the salt is properly purified and treated. Contents of Cu, Fe and Pb, in the analyzed salt samples were lower than that of recommended values of Codex Standards and Indian Standards.

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Table 1: Concentration (mg/kg) of elements (Na, K, Cu, Fe and Pb) in selected salt samples

S.N.	Salt Samples	Sample Codes	Concentration (mg/kg)				
			Copper	Iron	Lead	Potassium	Sodium
	Rock salt/Sendha	RS1	0.005	1.348	0.14	0055.86	0596.82
	Black salt	BS2	0.035	1.520	0.12	05321.4	0870.24
	White salt	WS3	0.014	0.907	0.13	20972.0	0893.76
	Puro healthy salt	PHS4	0.006	0.323	0.16	00210.7	1127.00
	Iodized salt	IS5	0.009	0.459	0.17	11701.2	1029.00
	Pink Himalayan salt	PHS6	0.006	1.135	0.16	19070.8	0936.88

Table 2: Maximum limit of heavy metals in edible salts (mg/kg)

S.N.	Elements	Codex Standards	Indian Standards
	Copper	2	2
	Iron	10	50
	Lead	2	2

Codex Alimentarius Commission (2001)