Physics International 5 (2): 128-131, 2014
ISSN: 1948-9803

doi:10.3844/pisp.2014.128.131 Published Online 5 (2) 2014 (http://www.thescipub.com/pi.toc)

STUDY OF SOME HEAVY METALS AND TRACE ELEMENTS

AL-Rajhi, M.A.

Department of Physics, College of Science, Al Imam Mohammad Ibn Saud Islamic University,
P.O. Box 90950, Riyadh 11642, Kingdom of Saudi Arabia

Received 2014-03-16; Revised 2014-03-21; Accepted 2014-04-22

ABSTRACT

This study provides an overview of the measurements of trace elements and heavy metals in table salt in Saudi Arabia. The aim of this study is to investigate the heavy metal concentration in different type of salt samples consumed in Riyadh Saudi Arabia and comparing the concentrations of such elements with the limits recommended by the World Health Organization (WHO) and Food and Agriculture Organization (FAO). Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES) has been used for sample measurement. The result showed that the concentration of heavy metals Cd, Pb, As and Al and trace elements Cr, Zn, Cu, Fe, Mg, Mn, Ni, Se and V fall far below the maxim permissible level set by the WHO and Food and FAO. It can therefore be concluded from this study the table salt, which are sold in Riyadh safe, healthy and free of any metal contaminants.

Keywords: Heavy Metals, Trace Element, ICP-OES, Table Salt and Riyadh

1. INTRODUCTION

Salt plays a significant function in the processes of digestion and essential element in the diet of humans, animals and plants. Salt is one the mostly used food additive with unique place in food consumption. Salt (sodium chloride) is an essential additive which routinely added to majorities of foods not only for improving taste but also as a preservative to many canned, salted and pickled or fresh foods. The harvest of salt from the surface of the salt lakes dates back to at least 6000 BC, making it one of the oldest food additives in human history (Cheraghali *et al*., 2010). Salt brings out natural flavors and makes food acceptable, protects food safety by retarding the growth of spoilage microorganisms, gives proper texture to processed foods, serves as a control agent to regulate the rate of fermentation in food processing, strengthens gluten in bread, provides color, aroma and appearance consumers expect and is used to create the gel necessary to process meats and sausages. Its industrial, medical and other uses are numerous. Different types of salt have different minerals, giving each one its unique flavour. The production of common salt is one of the most ancient and widely distributed industries in the world. Crude salt produced in a properly designed salt work has a purity of 90-95.5% Nacl. Industrial salt can be referred to as unrefined salt. It does not go through all the processes of refining salt. Crude salt is often directly ground, packed and marketed before being sold for humanuse (Lindberg, 1992). Salt (sodium chloride) is an essential additive which routinely added to majorities of foods not only for improving taste but also as a preservative to many canned, salted and pickled or fresh foods. The harvest of salt from the surface of the salt lakes dates back to at least 6000 BC, making it one of the oldest food additives in human history. Refined salt, which is most widely used presently, is mainly sodium chloride. Every year, several hundreds of million tons of salt is produced worldwide. However, food grade salt accounts for only a small part of salt production in industrialized countries although worldwide food uses account for 17.5% of salt production. In spite of considerable variation, daily intake of salt for many consumers is substantial (Usman and Filli, 2011a). Therefore, due to the daily consumption of table salt, any contamination in salt even in low level could create health risks to the consumers. Heavy metals contribute significantly to the

 DOI: 10.3844/pisp.2014.128.131

pollution of the environment as a result of human activities such as mining, smelting and the transfer of electrical energy and agriculture (Aliu *et al*., 2013). Recently, incidence of heavy metal contamination in table salt has been investigated worldwide. The current investigation looking at evaluating the heavy metal concentration in the most common types of table salts in local market of Riyadh city, kingdom of Saudi Arabia.

2. MATERIALS AND METHODS

2.1. Samples Collection and Preparation

A total of six table salt were collected from the supermarkets around the city of Riyadh and transported in plastic bags to the environmental research laboratory at AL imam Mohammad Ibn Saud Islamic University for elemental analysis. Samples were dried and after drying, samples were grained into a fine powder using a ceramic mill and stored in polyethylene bags until used for acid digestion.

2.2. Chemicals and Reagents

All the standard stock solutions of heavy metals were certified reference materials that were purchased from agilent technologies (USA). HNO_3 and H_2O_2 were heavy metal analysis grade and purchased from Wako Chemical Co. (USA). Reagent water, toluene and acetone were of analytical reagent grade and purchased from J.T. Baker (USA).

2.3. Acid Digestion of Samples

About 10 mL, high purity HNO_3 and 2 mL H_2O_2 were added to the beaker containing 2 g of dry samples placed in the fume cupboard for two days for digestion. The mixture was then digested at 80°C till the transparent solution was achieved. After cooling, the digested samples were filtered using Buchner funnels and the filtrate was diluted to 50 mL with distill water. The final solution were used for the elements analysis namely Cd, Cr, Cu, Fe, K, Mg, Mn, Ni, Pb, Zn, As, Se and Al by ICP optical emission spectrometer.

2.4. Spectrometric Analysis

The measurements were performed using a GENESIS ICP optical emission spectrometer (SPECTRO Analytical Instruments, Kleve, Germany) with axial plasma observation. The instrument includes a Paschen-Runge mount spectrometer, constructed employing the Optimized Rowland Circle Alignment (ORCA) technique. It consists of two hollow section cast shells, designed for direct thermal stabilization and small volume. 15 pre-aligned linear CCD detectors are installed on the outside of the optics body, which allow fast, simultaneous spectrum capture of the wavelength range between 175 nm and 777 nm. For UV access (<200 nm), the optical system purged with argon. The purge rate during normal operation is 0.5 L/min. To enable method transfer between individual instruments, Intelligent Calibration Logic (ICAL) was used to normalize the wavelength and the intensity scale of the optical system to a reference optic (“optic master”). Stability of the forward power in the case of rapidly changing sample loads was achieved through use of an air-cooled ICP-generator, based on a free running 27.12 MHz system. All ICP operating parameters were software controlled. The ICP-OES instrument was initialized and allowed to achieve thermal equilibrium over 30 min. Multi-element Solution Standards obtained from Agilentechnology were used to calibrate and quantitate sample results. The Lower Detection Limit of the system (LDL) was calculated and found to be 0.00001 mg kg^{-1} on the average. ICP-OES determinations of elements concentration were performed using the emission lines 228.802, 267.716, 324.752, 238.204, 766.490, 285.213, 259.372, 231.604, 220.353, 213.857, 189.641, 196.090, 384.401 and 311.071 λ (nm) for the elements Cd, Cr, Cu, Fe, K, Mg, Mn, Ni, Pb, Zn, As, Se, Al and Vrespectively.

3. RESULTS

The results of elemental analysis in salt samples purchased from Riyadh local market are presented in **Table 1 and 2**. **Table 1** shows the concentrations of Mn, Ni, Zn, Cr, Cu and Fe, these elements lie within the range (0.0010- 0.0010 mg kg^{-1}) for Mn, (0.0002-0.0006 mg kg^{-1}) for Ni, (0.0006-0.0025 mg kg^{-1}) for Zn, (0.0001-0.0005 mg kg^{-1}) for Cr, (0.0001-0.0009 mg kg^{-1}) for Cu and (0.0001-0.0120 mg kg^{-1}) for Fe. On average the value were 0.0003 mg kg^{-1} (Mn), 0.0003 mg kg^{-1} (Ni), 0.0012 mg kg^{-1} (Zn), 0.0002 mg kg^{-1} (Cr), 0.0005 mg kg^{-1} (Cu) and 0.0040 mg kg^{-1} (Fe). The concentration of Pb, As, Se, V, Al and Cd ranged from 0.0029-0.0114 mg kg^{-1}, 0.0031-0.0132 mg kg^{-1}, 0.0037-0.0170 mg kg^{-1}, 0.0006-0.0022 mg kg^{-1}, 0.0002-0.0645 mg kg^{-1} and 0.0001-0.0002 mg kg^{-1} with an average value of 0.0072, 0.0103, 0.0126, 0.0013, 0.0154 and 0.0001 respectively as shown in **Table 2**.

Table 1. Concentration and statistical summary of Cu, Fe, Mn, Ni, Zn and Cr in table salt samples

Samples no	Mn	Ni	Zn	Cr	Cu	Fe
1	0.0005	0.0003	0.0022	0.0003	0.0006	0.0049
2	0.0005	0.0002	0.0006	0.0002	0.0005	0.0038
3	LDL	0.0002	0.0008	0.0001	0.0003	0.0019
4	0.0001	0.0005	0.0025	0.0002	0.0009	0.0025
5	0.0010	0.0006	0.0010	0.0005	0.0007	0.0120
6	0.0000	0.0003	0.0006	0.0002	0.0004	0.0025
Min	0.0001	0.0002	0.0006	0.0001	0.0001	0.0001
Max	0.0010	0.0006	0.0025	0.0005	0.0009	0.0120
Average	0.0003	0.0003	0.0012	0.0002	0.0005	0.0040
Std	0.0003	0.0002	0.0007	0.0001	0.0002	0.0036

Table 2. Concentration and statistical summary of Pb, As, Se, V, Al and Cd in table salt samples

Samples no	Pb	As	Se	V	Al	Cd
1	0.0114	0.0132	0.0170	0.0022	0.0197	LDL
2	0.0112	0.0131	0.0165	0.0019	0.0053	0.0001
3	0.0068	0.0104	0.0131	0.0014	0.0030	0.0001
4	0.0055	0.0107	0.0127	0.0010	0.0029	0.0002
5	0.0066	0.0117	0.0136	0.0012	0.0124	LDL
6	0.0061	0.0097	0.0119	0.0011	0.0645	LDL
Min	0.0029	0.0031	0.0037	0.0006	0.0002	0.0001
Max	0.0114	0.0132	0.0170	0.0022	0.0645	0.0002
Average	0.0072	0.0103	0.0126	0.0013	0.0154	0.0001
Std	0.0028	0.0032	0.0041	0.0005	0.0210	0.0001

4. DISCUSSION

Daily consumption of salt varies from people to people and person to person by the culture and food style, therefore any contamination in salt even at a low level can create health risks for consumers. From the result the study have relieved that the concentration of the selective elements are very low, however the high concentration of the elements Cd, Cr, Cu, Fe, K, Mg, Mn, Ni, Pb, Zn, As, Se, Al and V were observed in sample number 5,4,1,1,5,4,6,2,1,1 and 1 respectively. The obtained results showed that the average value of trace elemets Zn, Pb, Cu, Mg and Cd are less than the similar data reported by (Usman and Filli, 2011b) (Nwachoko *et al*., 2012). Its well known in the literature trace elements have an effective role and occupies an important position in many biolgical processes (Mohammed *et al*., 2011). Up on comparing the results of elements concentration with FAO/WHO limits arsenic in all the samples is below the limit 0.5 mg kg^{-1}. Lead in the result of the analyses, has values less than that of the FAO/WHO limits of 2 mg kg^{-1}. High level of lead has being noted to cause damages in human. Damaging effect of lead include disruption of the biosynthesis of hemoglobin and anemia, rise in blood pressure, kidney damage and brain damage. Cadmium from the results was noted to have values far below the FAO/WHO limit of 0.5 mg kg^{-1} (FAO/WHO, 2011). Cadmium overload can damage renal nerves, obstruction in the lungs, irritation of the stomach, genetic disorder and it is a known human carcinogen that harms DNA molecules directly and disturbs its repair system that helps to prevent cancer (Ames and Wakimoto, 2002). Zinc from the analysis is less than WHO limit (1997) of 0.5 mg k^{-1}. WHO recommended 2.0 mg kg^{-1} maximum of copper content. Copper is a heavy metal and much consumption of it can be dangerous to human health. It is advisable that salt contains less quantity of this metal or if possible not to contain it at all (CODEX, 2006). On the other hand the micro concentration of trace element it is good for health especially Selenium. Because Se has many potential health benefits beyond meeting basic nutritional requirements. Numerous studies have demonstrated the ant carcinogenic activities of some organic forms of Se against certain types of cancer (Reid *et al*., 2002; Whanger, 2002).

5. CONCLUSION

This study established a database of heavy metals and trace elements concentration in different types of table salt samples in Riyadh, KSA. The result showed that the concentration of heavy metals and trace elements were lower than WHO and FAO recommended level. It can therefore be concluded from this study the table salt, which are sold in Riyadh safe, healthy and free of any metal contaminants.

6. ACKNOWLEDGMENT

The researcher would like to thank many colleagues for their valuable help with these experiments.

7. REFERENCES

Aliu, S., B. Gashi, I. Rusinovci, S. Fetahu and R. Vataj, 2013. Effects of some heavy metals in some morpho-physiological parameters in maize seedlings. Am. J. Biochem. Biotechnol., 9: 27-33. DOI: 10.3844/ajbbsp.2013.27.33

Ames, B.N. and P. Wakimoto, 2002. Are vitamin and mineral deficiencies a major cancer risk? Nature Rev. Cancer, 2: 694-704. DOI: 10.1038/nrc886

Cheraghali, A.M., F. Kobarfard and N. Faeizy, 2010. Heavy metals contamination of table salt consumed in Iran. Iranian J. Pharm. Res., 9: 129-132.

CODEX, 2006. Codex standard for food grade salt CX Stan.

FAO/WHO, 2011. Joint FAO/WHO food standards programme codex committee on contaminants in foods. FAO/WHO, Netherlands.

Lindberg, W., 1992. A suggestion for the terminology of certain mineral deposits economic geology. Australian J. Geol., 8: 69-78.

Mohammed, S.G., H.T. Abdulsahib, I.M. Jasim and M.T. Jabbar, 2011. Assessment of camel meat pollution with trace metals in desert area of basra province. Am. J. Agric. Biol. Sci., 6: 475-479. DOI: 10.3844/ajabssp.2011.475.479

Nwachoko, N.C., U.A. Ibiam, K.N. Agbafor and P.M. Aja, 2012. Determination of asernic, lead, cadmium, zinc and iodine in some salt samples sold in south-east Nigeria and of these metals on protein and haemoglobincontent of albino rats. IJABR, 2: 599-601.

Reid, M., A.J. Duffield-Lillico, L. Garland, B.W. Turnbull and L.C. Clark *et al*., 2002. Selenium supplementation and lung cancer incidence: An update of the nutritional prevention of cancer trial. Cancer Epidemiol. Biomarkers Prev., 11: 1285-1291. PMID: 12433704

Usman, M.A. and K.B Filli, 2011a. Determination of essential elements and heavy metals contained in table salt. J. Res. Nat. Dev., 9: 1596-8308.

Usman, M.A. and K.B. Filli, 2011b. Determination of essential elements and heavy metals contained in table salt. J. Res. Nat. Dev., 9: 1596-8308.

Whanger, P.D., 2002. Selenocompounds in plants and animals and theirbiological significance. J. Am. Coll Nut., 21: 223-232. DOI: 10.1080/07315724.2002.10719214