Global Journal of Science Frontier Research: B
Chemistry
Volume 15 Issue 1 Version 1.0 Year 2015
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Contamination of Toxic Heavy Metal in Locally Made Plastic Food Packaging Containers

By Saimah Khan & Abdul Rahman Khan
Integral University, India

Abstract- Human exposure to toxic heavy metals creates a major health hazards. The main objectives of our study was to examine the concentration of toxic heavy metals like Lead (Pb), Copper(Cu), Nickel(Ni), Zinc(Zn), Manganese(Mn), Chromium(Cr) and Cadmium(Cd) in locally made food containers purchased from various districts of U.P (India). All samples are analyzed at 60±2°C for 2hrs in different simulating solvents as per BIS, IP, USP and other guidelines by using atomic absorption spectrophotometer(AAS). The results shows that leaching of heavy metals occur in all samples and follows the order:

Pb(1.9-0.0001 ppm) > Cu(1.61-0.0001 ppm) >Ni(1.31-0.001 ppm) > Zn(1.02 -0.001 ppm) > Mn(1.01-0.0001 ppm) > Cr(0.14-0.0001 ppm) > Cd(0.01-0.0001 ppm).

Keywords: food containers, concentrations, heavy metals, toxic, health, plastic.

GJSFR-B Classification : FOR Code: 250201

Strictly as per the compliance and regulations of :

Contamination of Toxic Heavy Metal in Locally Made Plastic Food Packaging Containers

Saimah Khan [α] & Abdul Rahman Khan [σ]

Abstract- Human exposure to toxic heavy metals creates a major health hazards. The main objectives of our study was to examine the concentration of toxic heavy metals like Lead (Pb), Copper(Cu), Nickel(Ni), Zinc(Zn), Manganese(Mn), Chromium(Cr) and Cadmium(Cd) in locally made food containers purchased from various districts of U.P (India). All samples are analyzed at 60±2°C for 2hrs in different simulating solvents as per BIS, IP, USP and other guidelines by using atomic absorption spectrophotometer(AAS). The results shows that leaching of heavy metals occur in all samples and follows the order:

Pb(1.9-0.0001 ppm) > Cu(1.61-0.0001 ppm) >Ni(1.31-0.001 ppm) > Zn(1.02 -0.001 ppm) > Mn(1.01-0.0001 ppm) > Cr(0.14-0.0001 ppm) > Cd(0.01-0.0001 ppm).

Keywords: food containers, concentrations, heavy metals, toxic, health, plastic.

I. Introduction

Plastic containers used for food packaging are made from plastics based on the following polymers: polyethylene(low and high density), polypropylene, polyvinyl chloride, polystyrene etc. All plastics, apart from basic polymer, contain additional chemical compounds called additives (plasticizers, antioxidants, stabilizer, curing agent, colouring agent etc) which are added in small amount to attain certain desired properties. The final processed plastic is slightly different material as compared to the virgin polymeric plastic. These additives possess mobility and likely to transfer some low molecular weight non polymeric components into the packaged content under the influence of physicochemical factors such as sunlight, temperature, type of solvents (based on nature of food) and pH of the stored material[1-8].Thereby contaminating the food with the risk toxic health hazard to the consumer. Therefore, the guidelines for the proper use of plastic have been formulated all over the world and BIS formulate the national standard[9-17]. According to this, metal content should not be more than 1ppm and Cd should not be more than 0.1ppm. Therefore, it is necessary to determine the concentration of heavy metals such as Zn, Ni, Mn, Cu, Cr, Cd and Pb in locally made food containers to safeguard the health of a consumer.

Various studies have done on leaching of heavy metal from food containers and found that the concentration of heavy metal is beyond the allowed limit[5,18]. Since heavy metals cannot be metabolized easily by the human body because it is five times more dense than water. Therefore, it can be accumulated in the body and when their concentration cross their permissible limit, can become harmful and causes toxic health hazards such as disorders in mental function, kidney, nervous system, respiratory system and many other physiological activities of the body cells and other organs[19-23].

Due to large consumption of plastic in India, several small scale industries forming plastic food container in irregular way by using harmful additives which are usually above their allowed limits and these product are generally not tested by regulatory agencies for safety of consumer. This leads to reduced quality of product. In the regard, this research was designed to determine the concentration of heavy metals like Zn, Ni, Mn, Cu, Cr, Cd and Pb in local made food container which were purchased from various districts of U.P., India.

II. Material and Methods

Thirty samples of five different brands of food containers were purchased from various districts of U.P, India, for the assessment of heavy metals (Zn, Ni, Mn, Cu, Cr, Cd and Pb). The food containers were washed thoroughly with sterilized double distilled water prior to leaching. Based on nature of food, five different food simulating solvents are used and these are Double distilled water, Acetic acid (3% v/v), Ethanol (8% v/v), Sodium chloride (0.9% w/v) and Sodium carbonate (5% w/v). The food containers were exposed in 100ml of each simulating solvents in a sterile beaker at a ratio of 1 cm^2 /2 ml. The samples were kept at 60 ±2° C for 2 hours. Parallel sets having simulating solvents only served as basal control were also run under identical conditions. The stimulant solvents (100ml) were taken in a beaker and digested in a fuming chamber using concentrated nitric acid. The digested samples were make up to 10ml using 0.1N HNO_3. The quantitative analysis of final digested samples were done by using Perkin-Elmer-500 atomic absorption spectrophotometer (AAS). The instrument was first calibrated with standard solution prepared from stock solution as provided by Merck. The metals concentration of different leachates of samples were determined in triplicate and the result is given as a mean ±SD. The heavy metals concentration

Author α σ: Department of Chemistry, Faculty of Sciences, Integral University, Lucknow, India. e-mail: saimah2606@gmail.com

of different samples are presented in ppm. The concentration of metal should not be more than 1ppm (Cd should not be more than 0.1ppm) according to BIS,IP,USP and other regulatory agencies.

III. Results and Discussion

The results showed that all samples were found to contain Zn, Ni, Mn, Cu, Cr and Pb in varying concentrations are given in Figure 1 to 5.

* The mean concentration of Zn which is above allowed limit (1ppm) in the samples follows the order: *S2 (1.02 ppm in 3% acetic acid) > S4 (1.006 ppm in 0.9% NaCl) .*

* The mean concentration of Ni which is above allowed limit (1ppm) in the samples follows the order: *S4(1.31 ppm in double distilled water) > S3(1.21ppm in double distilled water) > S2(1.102ppm in 3% acetic acid) > S2(1.08ppm in 0.9% NaCl) >S5 (1.02ppm in 5% Na_2CO_3) > S5(1.01 ppm in 3% acetic acid).*

* The mean concentration of Mn which is above allowed limit (1ppm) in the samples follows the order: *S5(1.01ppm in 0.9% NaCl) > S2(1.008ppm in double distilled water) > S3(1.001 ppm in double distilled water).* The concentration of Mn was not detected in case of 8% Ethanol.

* The mean concentration of Cu which is above allowed limit (1ppm) in the samples follows the order: *S5(1.61ppm in 3% acetic acid) > S4(1.30 ppm in 0.9% NaCl) > S4(1.02 ppm in double distilled water).*

* Except in case of 0.9% NaCl, all samples were found to contain Cr under permissible limit. The highest mean concentration of Cr(0.14ppm) was detected in case of 3% acetic acid.

* The mean concentration of Pb which is above allowed limit (1ppm) in the samples follows the order: *S1(1.9 ppm in double distilled water) > S3(1.2 ppm in 3% acetic acid) > S5 (1.1 ppm in 5% Na_2CO_3) > S1 (1.04ppm in 5% Na_2CO_3) > S1(1.029 ppm in 8% ethanol) > S2(1.002ppm in 3% acetic acid).*

* All samples were found to contain Cd under allowed limits (0.01 ppm).

The differences were significant between mean concentrations of metals in different food containers samples in double distilled water ($P<0.05$), 3% acetic acid($P<0.05$), 8% ethanol($P<0.05$), 0.9% NaCl($P<0.05$) and 5% Na_2CO_3 ($P<0.05$).

Thus, the result shows that higher percentage of leaching of heavy metals above allowed limit follows the pattern:

Pb(1.9-1.002ppm) in S1 > Cu(1.61-1.02ppm) in S5,S4 > Ni(1.31-1.01ppm) in S4,S3,S2,S5 > Zn(1.02-1.006ppm) in S2,S4 > Mn(1.01-1.001ppm) in S5,S2,S3.

Percentage of leaching in different food stimulant solvents shows the pattern:

Double Distilled Water > 3% Acetic Acid > 0.9% NaCl > 5% Na_2CO_3 > 8% Ethanol.

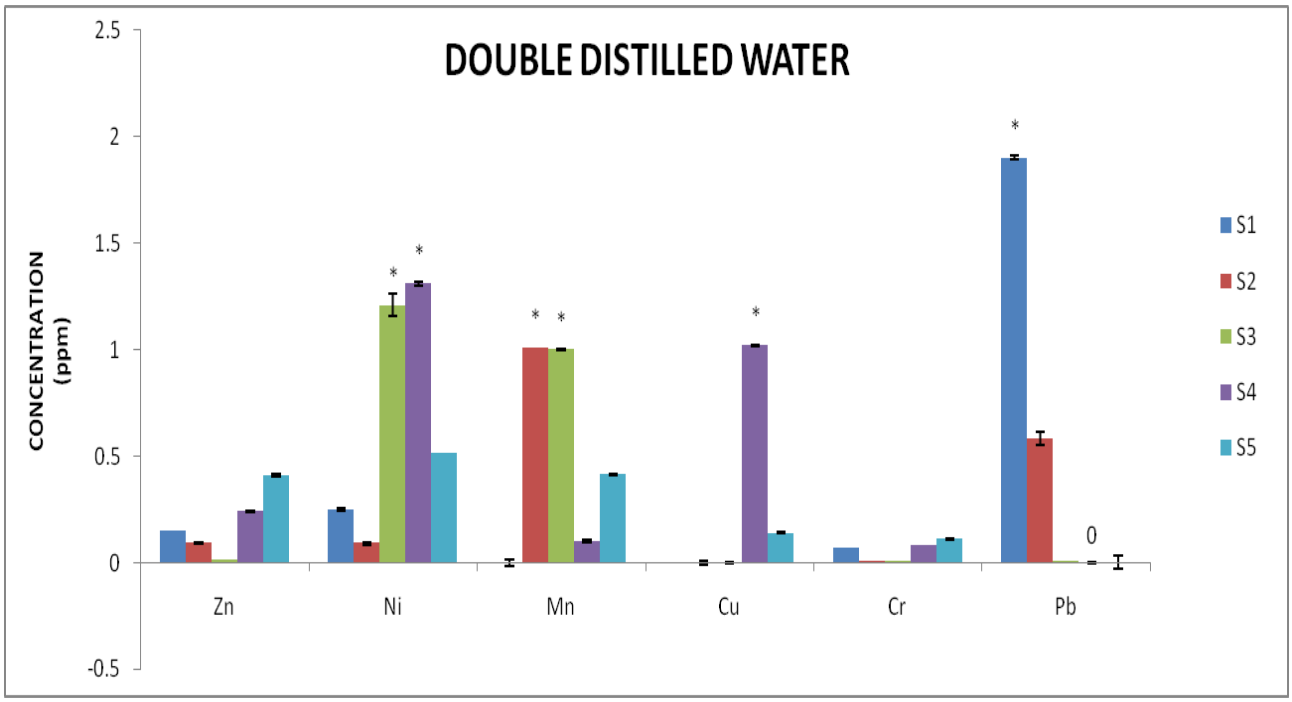

Figure 1 : The concentration of metals (ppm) in double distilled water at 60±2°C for 2 hrs. The result were reported as a mean ±SD from three set of experiments.*p<0.05

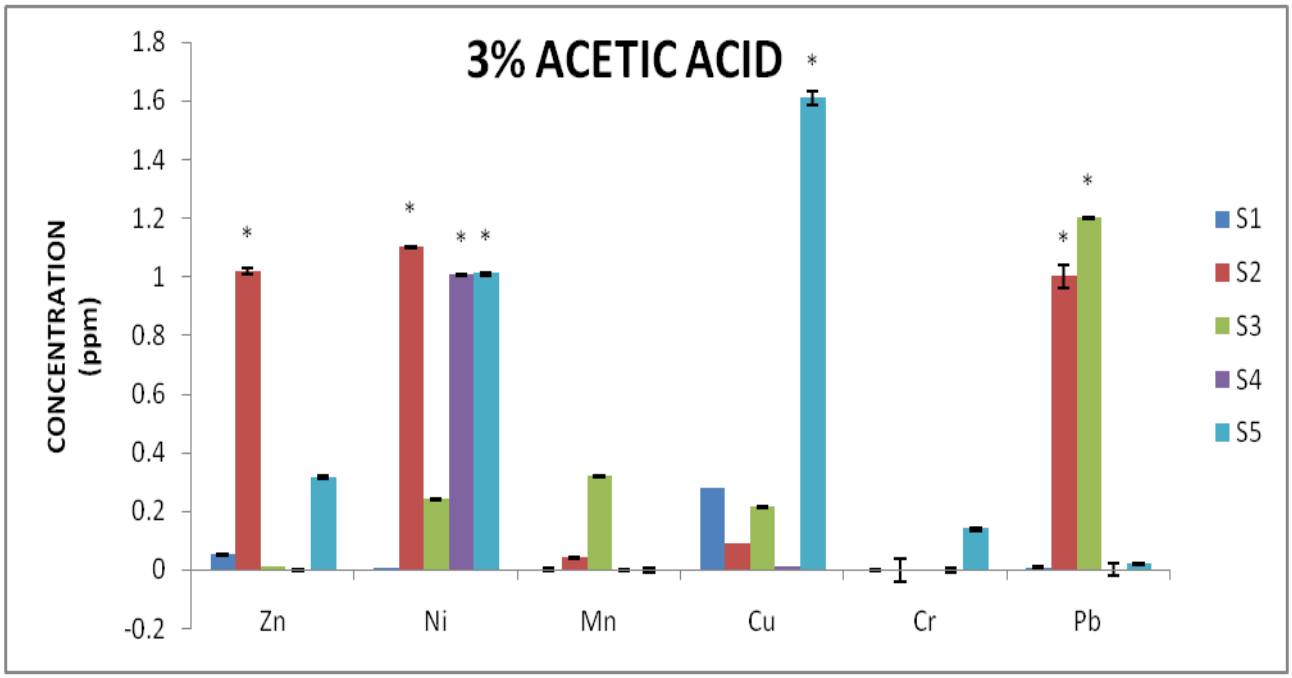

Figure 2 : The concentration of metals (ppm) in 3% acetic acid at 60±2°C for 2 hrs. The result were reported as a mean ±SD from three set of experiments.*p<0.05

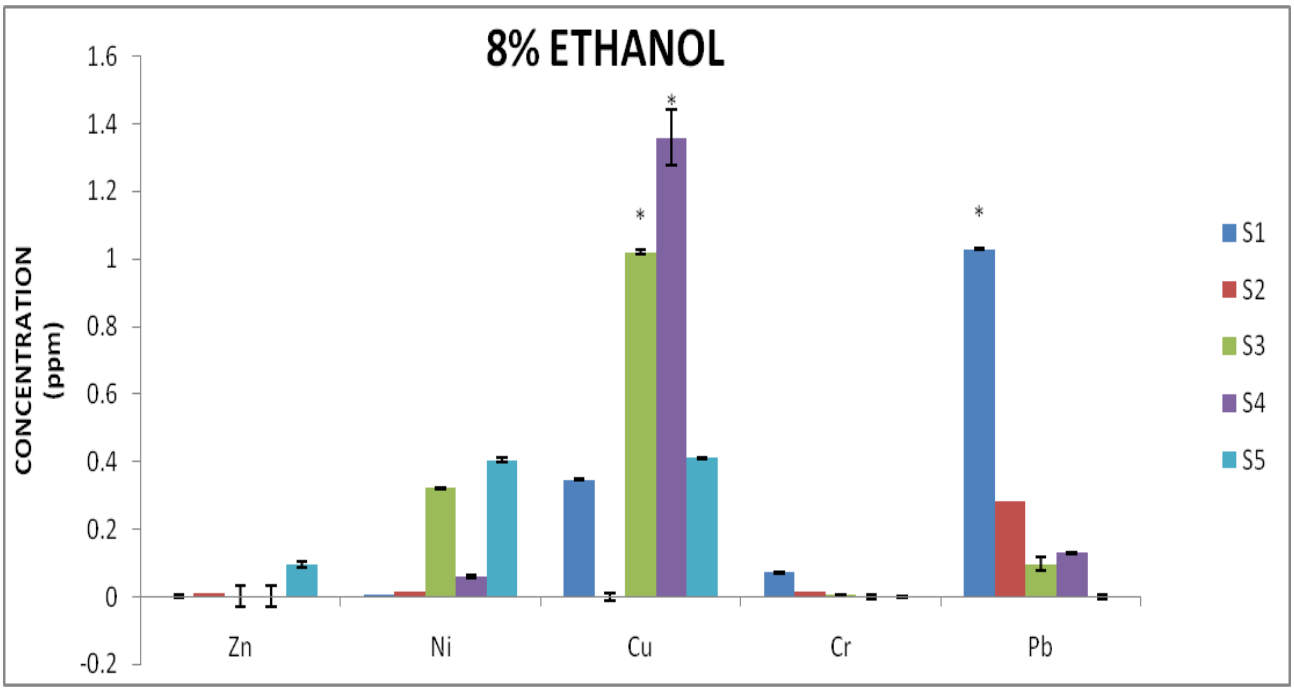

Figure 3 : The concentration of metals (ppm) in 8% ethanol at 60±2°C for 2 hrs. The result were reported as a mean ±SD from three set of experiments.*p<0.05

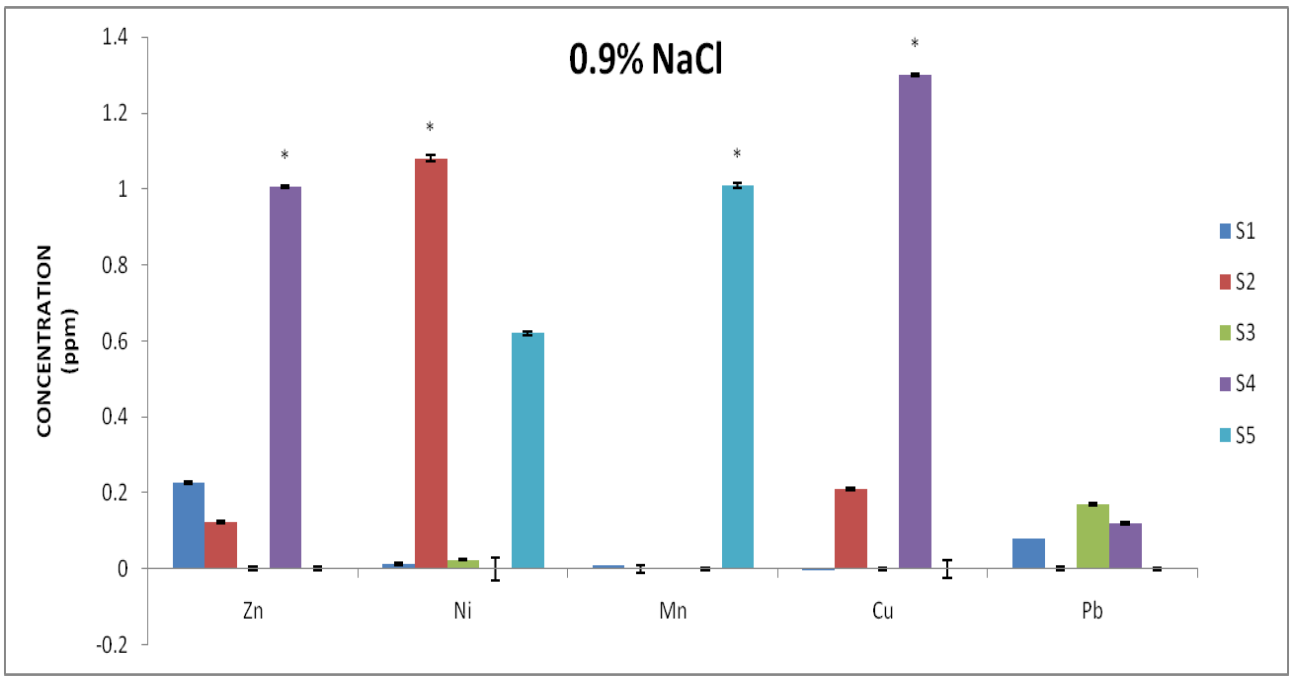

Figure 4 : The concentration of metals (ppm) in 0.9% NaCl at 60±2°C for 2 hrs.
The result were reported as a mean ±SD from three set of experiments.*p<0.05

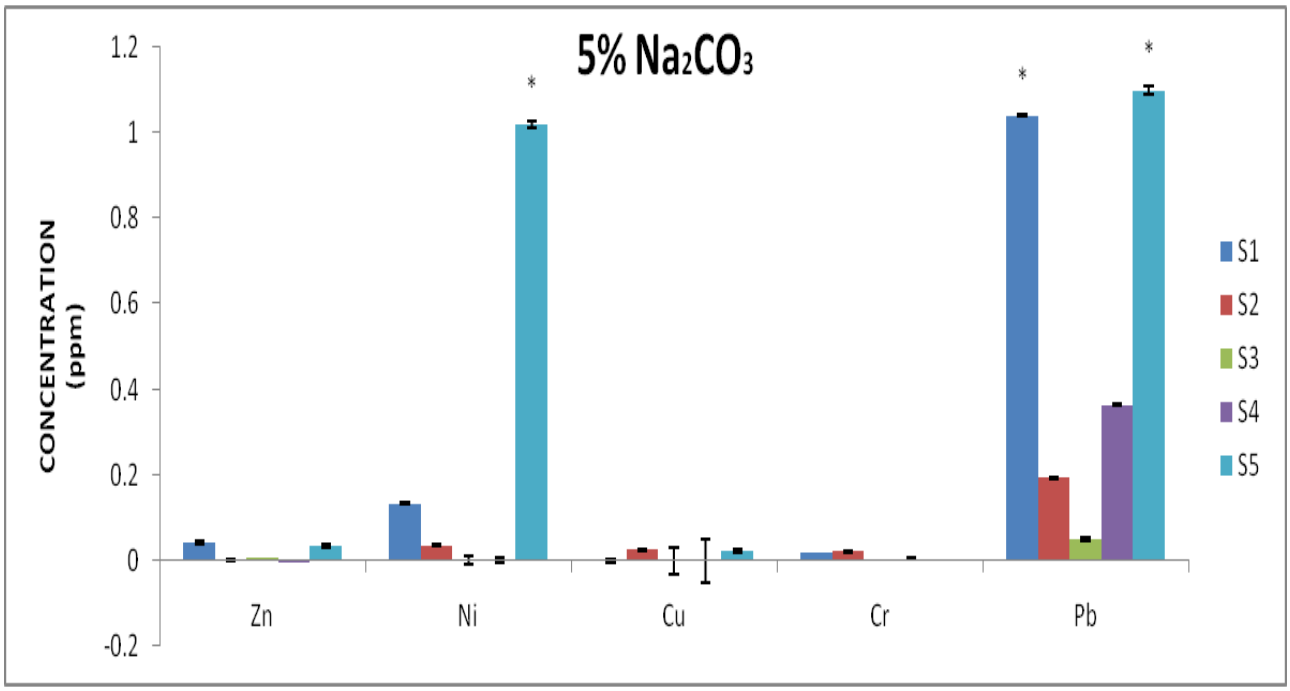

Figure 5 : The concentration of metals (ppm) in 5% Na2CO3 at 60±2°C for 2 hrs.
The result were reported as a mean ±SD from three set of experiments.*p<0.05

IV. Conclusion

This report documented the exposure of human to toxic heavy metals through plastic food containers. The food containers purchased from various districts of U.P,(India), contain toxic heavy metals such as Pb, Cu, Ni, Zn, Mn, Cr and Cd. Out of which the concentration of Pb, Cu, Ni, Zn and Mn were above allowed limit that may creates a major health problems for consumer. Therefore, it is need to safeguard the health of consumer through awareness of society about harmful effects of plastic food containers, especially local made containers having no specification of additives.

References Références Referencias

1. Alam MS, Ojha CS, Seth PK and Srivastava SP.Implication of physico-chemical factors on the immigration of UV absorbers from commonly used plastics. Indian J Environ Protect.,1990; 10: 99.
2. Khaliqui MA, Alam MS and Srivastava SP.Implications of physico-chemical factors on the immigration of phthalate esters fromtubing commonly used for oral / nasal feeding. Bull Environ Contam Toxicol.,1992; 48:572–578.
3. Junaid M, Pant AB, Bajpai K, Sharma VP and Seth PK. Safety evaluation of plastic biomedical products: transfusion bottles. Abstract in the Proceedings of 85th National Science Congress, 1998; 86.
4. Figge K. Migration of additives from plastic films to edible oil and fat simulants. Food Cosmet Toxicol., 1977; 10: 815–827.
5. Srivastava SP, Saxena AK and Seth PK. Safety evaluation of some of the commonly used plastic materials in India. Indian J Environ Health., 1984; 26 (4): 346–354.
6. Parmar D, Srivastava SP, Srivastava Sri P and Seth PK. Hepatic mixed function oxidases and cytochrome P450 contents in rats pups exposed to DEPH through mother's milk. Drug Metab Dispos., 1985; 37: 1203.
7. Jenke D. A general assessment of the physiochemical factors that influence leachables accumulation in pharmaceutical drug products and related solutions. PDA JPharm Sci Technol.,2011; 65(2):166-76.
8. Gallelli JF AND Groves MJ. USP perspectives on particle contamination of injectable products. J Parenter Sci Technol., 1993; 47:289-92.
9. Bureau of Indian Standards. List of pigment and colorants for use in plastics in contact with food stuff and pharmaceuticals and drinking water, 1981: 9833.
10. Bureau of Indian Standards. Positive list of constituents of poly vinyl chloride and its copolymers in contact with food stuff, pharmaceuticals and drinking water, 1982:10148.
11. Bureau of Indian Standard. Positive list of constituents of styrene polymers in contact with food stuff, pharmaceuticals and drinking water, 1982: 10149.
12. Bureau of Indian Standards. Positive list of constituents of polypropylene and its copolymers in contact with food stuff, pharmaceuticals and drinking water, 1984:10909.
13. Bureau of Indian Standards. Method of analysis for determination of specific and/ or overall immigration of constituents of plastic materials and articles intended to come contact with food stuff, 1986: 9845.
14. The United States Pharmacopoeia: The National Formulary. USP-23. Untied State Pharmacopoeial Convention, Inc., 12601. Twinbrook Parkway, Rockville, MD 20852,1995.
15. British Pharmacopoeia. Plastic containers for aqueous solutions for intravenous infusion. (Ph. Eur. Test 3.2.7) Appendix XIXC, 1998.
16. Bureau of Indian Standards. Glass fiber reinforced plastics pipes, joints and fittings for use for potable water supply — specifications, 1994 (12709).
17. US EPA Cadmium compounds factsheet, 2003. Srivastava SP, Saxena AK and Seth PK. Safety evaluation of some of the commonly used plastic materials in India. Indian J Environ Health.,1984; 26 (4): 346–354.
18. Ulsaker GA and Korsnes RM. Determination of cyclohexanone in intravenous solutions stored in PVC bags by gas chromatography. Analyst., 1977; 102:882-3
19. Gidlow DA. Lead toxicity. Occup Med., 2004; 54:76-81.
20. Needleman HL Bellinger D. The health effect of low level exposer to lead. Annu Rev Pub Health., 1991; 12:111-140.
21. Tong S, von Schirnding Ye, Prapamontol T. Environmental lead exposer: a public health problem of global dimensions. Bull World Health Organ., 2000; 78:1068-1077.
22. Fels L, wunsch M, Baranowski J, Norska- Borowkal, Price R and Taylor. Adverse effects of chronic level lead exposer on kidney function- a risk group study in children. Nephrol Dial transplant., 1998; 13:2248-2256.
23. Markowitz G and Rosner D. ''Cater to the child'': the role of the lead industry in a public health tragedy, 1900-1995. Am J Public Health., 2000; 90: 36-46.

This page is intentionally left blank