Research Paper www.ijcps.com

International Journal of
Chemical and Pharmaceutical Sciences
2012, Sep., Vol. 3 (3)

ISSN: 0976-9390
IJCPS

Assessment of heavy metal contamination in plastic disposable cups frequently used in Lucknow

Naseem Ahmad*, Malik Nasibullah, Firoj Hassan, Abdul Rahman Khan and Masihurrahman

Department of Chemistry, Faculty of Applied Sciences, Integral University, Dasauli, Lucknow, India.

*Corresponding Author: E-Mail: nasmad4u@gmail.com

ABSTRACT

Human exposure to environmental heavy metals continues to be a major health concern. The main objectives of this study was to monitor the heavy metals concentration in the leachates of plastic disposable cups of ten different brands (locally made) which were frequently used in Lucknow, U.P.(India), in different simulating conditions *i.e.* double distilled water, ethanol (8%), acetic Acid (3%), sodium Chloride (0.9%) and sodium Carbonate (5%) at 25±2°C for 24 hrs (ambient conditions), 60±2°C for 2hrs (elevated conditions) and 04±1°C for 72 hrs (refrigerated conditions). The result showed that the leaching of heavy metals in all samples of plastic disposable cups were below than the permissible limits i.e. (1ppm) except Cd which is (0.01 ppm).

Key words: Heavy metals, Disposable cups, Leachates, Concentration.

1. INTRODUCTION

We are living in a plastic era. Plastics have created new horizons in every field of life ranging from packaging to use in space crafts and biomedical devices/ implants. If present trends continue, plastic is expected to become the market's largest sector within the next decade. The finished plastics are generally considered to be safe if they are manufactured at standard conditions using permitted chemicals recommended by national and international regulatory agencies and used properly [1-9]. Many inorganic chemical additives can be added to plastics in order to get desired physical, chemical, or mechanical properties. Additives used as stabilizers may include calcium and zinc. Pigments often contain metals such as lead, tin, arsenic, nickel, cadmium, barium, aluminum, titanium, and iron. These additives are not chemically bound to the matrix of the polymeric materials and leach out under the influence of physicochemical factors such as sun light, temperature, and type of solvents and pH of the stored commodity [10-17]. Release of hazardous substances from plastic products to air, extraction fluids, water, food, food simulants, saliva and sweat have been shown by chemical analysis for examples lead, tin and cadmium compounds that include organics, metals and volatile sulphur containing compounds may leach out from the plastic disposable cups into the contained solution [17-20]. Zinc based organic compounds are often used to initiate polymerization and wide ranging trace levels of zinc are found in plastic diluents [21]. There are numerous reports on the leachable, such as metals, DEHP, cyclohexanone and other organic and acidic compounds found in the solution of plastic articles [22-26]. Heavy metals, such as Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn are leached out in the simulating solvents from the finished plastic products [14, 27]. This can affect the normal physiological activities of the cells and other organs, as the levels of these metals were found above the permissible limits.

Cadmium is a carcinogen and causes kidney damage [28]. Lead is a neurotoxin and carcinogen. It can damage the nervous system, reproductive organs, cardiovascular system, liver, immune system and the kidney [29]. Some of the harmful health effects of lead are cumulative and irreversible [30]. Although lead exposure is a health hazard to human in general but children's are at a much greater risk [30-32].

2. MATERIALS AND METHODS

Ten brands of plastic disposable cups used in the present study were purchased from three major areas of Lucknow, Uttar Pradesh, India and washed thoroughly with sterilized double distilled water prior to leaching. Aseptic dried plastic cups were cut into small pieces of 1 cm^2 and immersed in 100 ml of either of simulating solvent viz. double distilled water, ethanol (8%), acetic Acid (3%), sodium Chloride (0.9%) and sodium Carbonate (5%) at 25±2°C for 24 hrs (ambient conditions) 60±2°C for 2hrs (elevated conditions) and 04±1°C 72 hrs (refrigerated conditions). Parallel sets having simulating solvents only were also run under identical conditions and were served as basal control. The leachates will be taken in flask and digested with concentrated Nitric acid and the volume of digested samples will be made up to 10 ml using 1% Nitric acid. The digested samples were analyzed for metal content, (Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn) using a Perkin- Elmer atomic absorption spectrophotometer (AAS). One way ANOVA test was used to evaluate differences among the control and samples. The *t- test* was used to evaluate the concentration difference in the simulating solvents. The significance was set at 0.05.

Metal content should not be more than 1.00 ppm (Cd should not be more than 0.1 ppm).

3. RESULT AND DISCUSSION

The results of our study showed that mean concentration of heavy metals in the various leachates of the cups analyzed are given in figure 1-35.

The concentrations of the selected heavy metals were determined in triplicate and the result is given as a mean ± standard deviation. The highest mean concentration of metals were detected generally at elevated conditions *e.i.* 60±2°C for 2hrs which are as-

The highest mean concentration of zinc was detected from S5 sample in 0.9% sodium chloride (0.814 ppm), nickel (0.691ppm) from S9 sample in 8 % ethanol, chromium, (0.845 ppm) from S4 sample in double distilled water, Iron, (0.654ppm) from S5 sample in double distilled water, copper (0.698 ppm) from S5 sample in double distilled water, manganese (0.641ppm) from S3 sample in double distilled water, cadmium (0.006 ppm) from S3 sample in double distilled water, S1& S6 in 8% ethanol and S1in 5 % sodium carbonate. There were lowest mean concentrations of these metals were found in refrigerated conditions *i.e.* 04±1°C for 72 hrs with some exceptions. At ambient condition *i.e.* 25±2°C for 24 hrs the mean concentration were detected generally intermediate between other two conditions. There were significant differences between mean concentrations of metals in different brands of samples.

The result showed that the leaching of heavy metals in plastic disposable cups is temperature dependant *i.e.* high at higher temperatures and at lower temperatures.

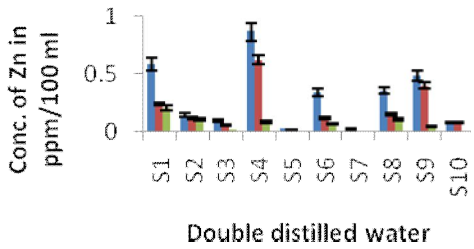

Figure 1

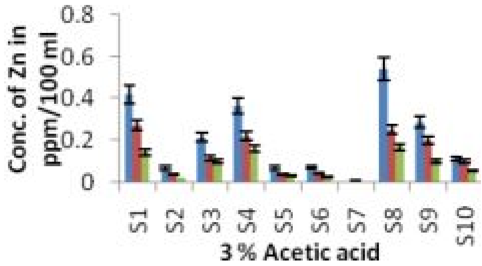

Figure 2

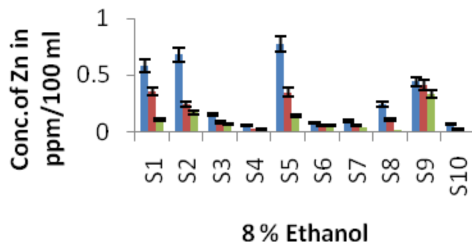

Figure 3

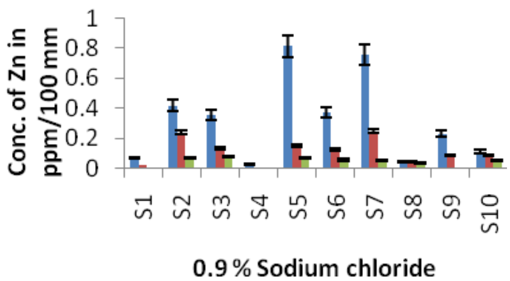

Figure 4

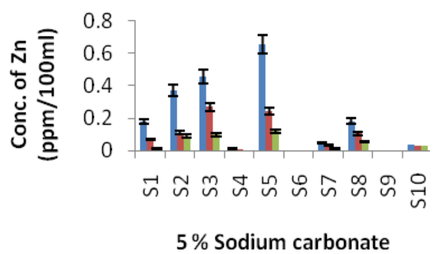

Figure 5

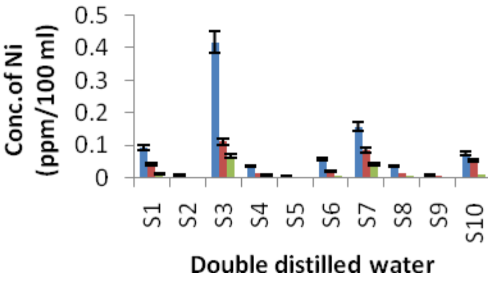

Figure 6

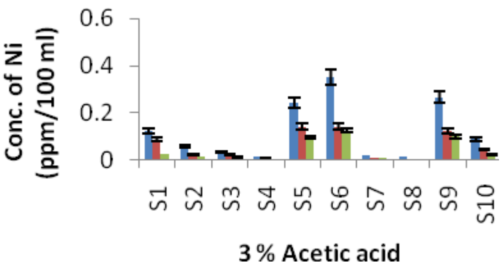

Figure 7

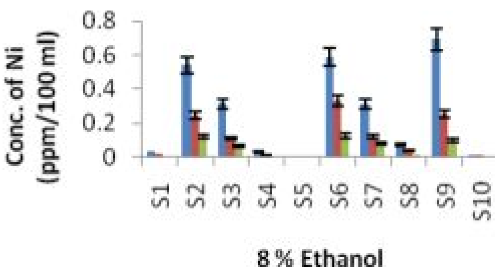

Figure 8

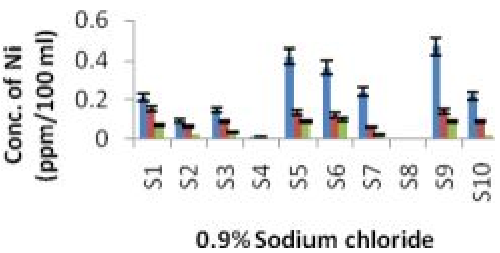

Figure 9

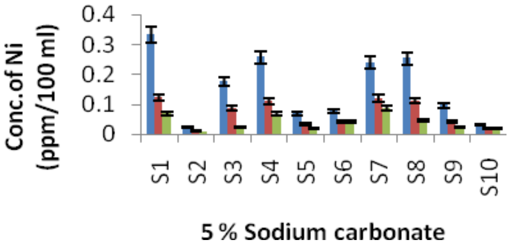

Figure 10

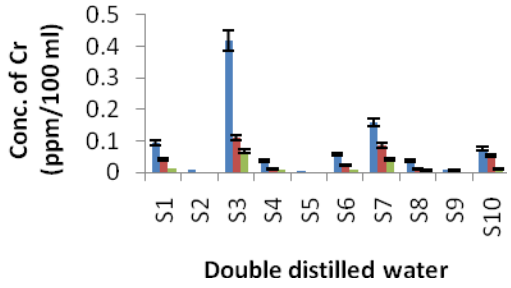

Figure 11

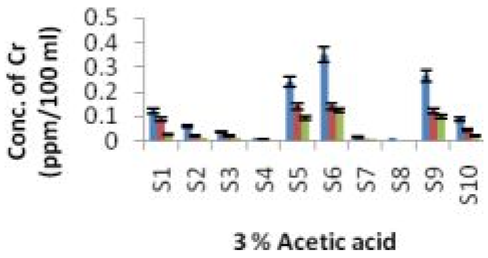

Figure 12

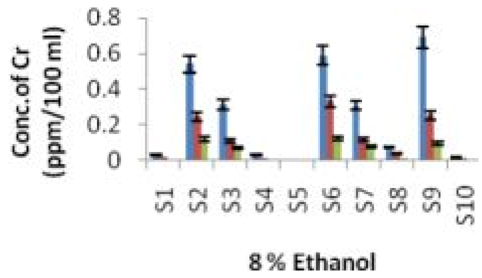

Figure 13

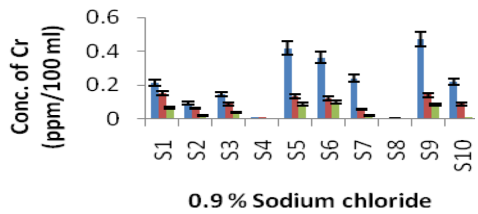

Figure 14

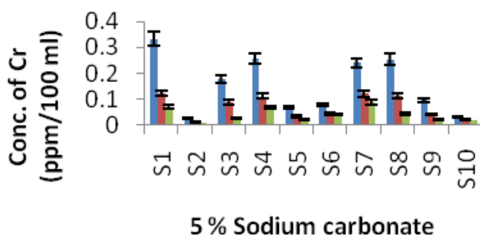

Figure 15

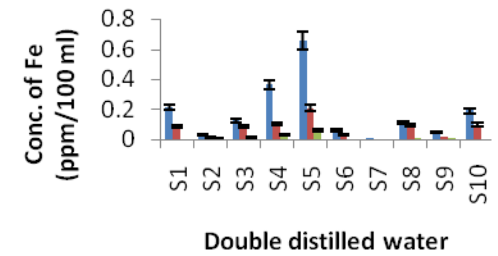

Figure 16

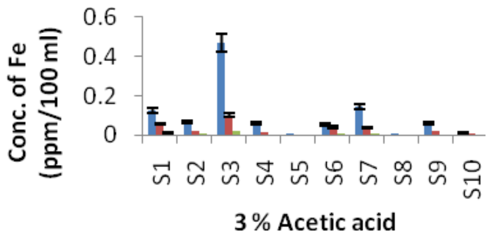

Figure 17

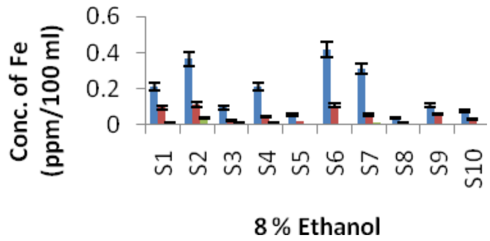

Figure 18

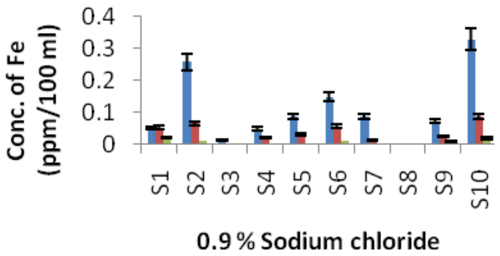

Figure 19

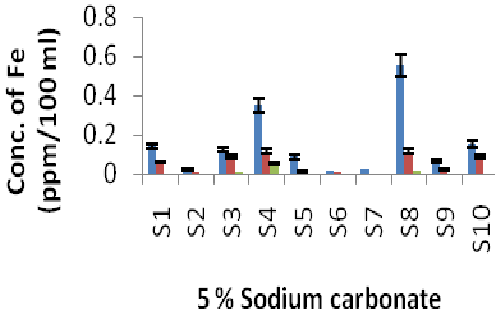

Figure 20

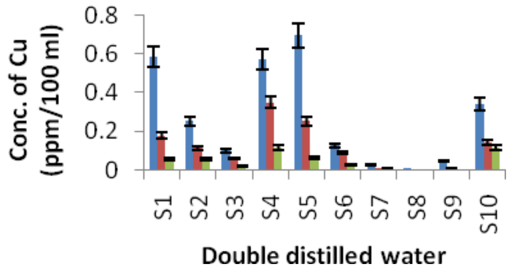

Figure 21

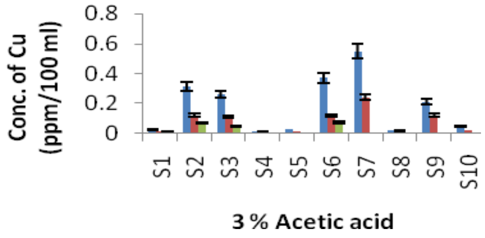

Figure 22

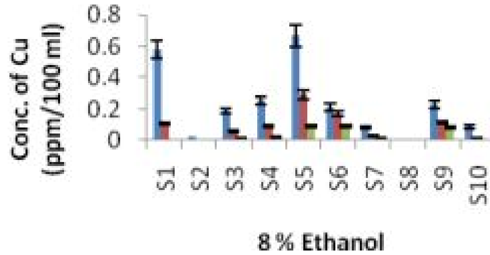

Figure 23

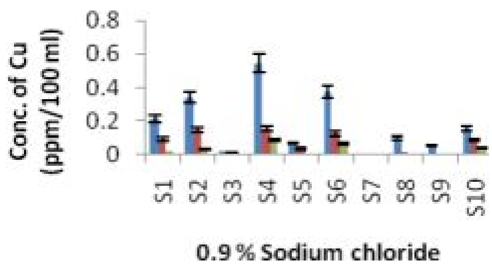

Figure 24

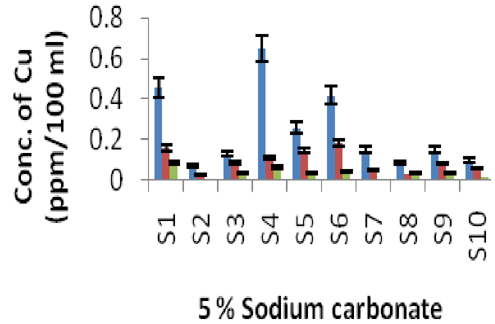

Figure 25

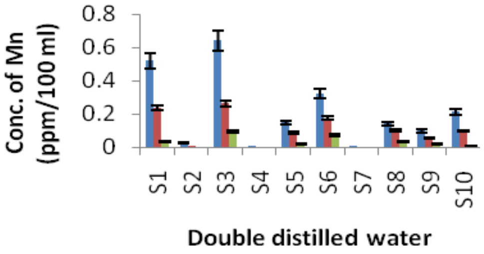

Figure 26

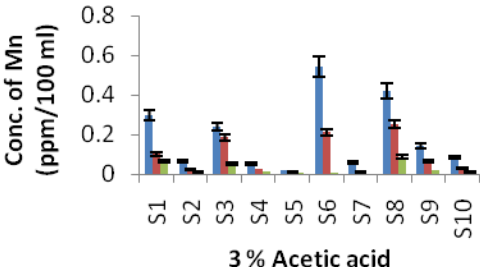

Figure 27

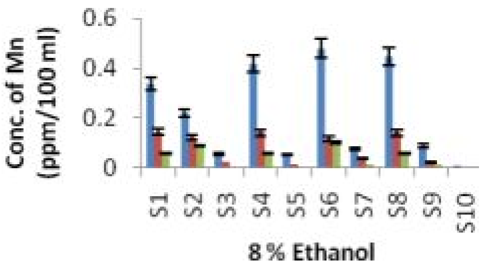

Figure 28

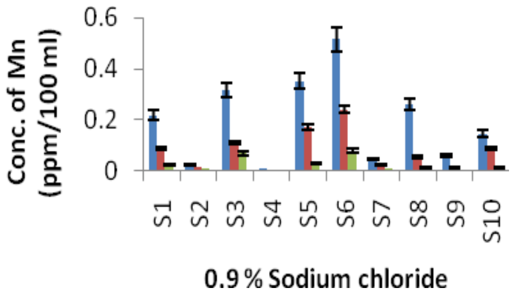

Figure 29

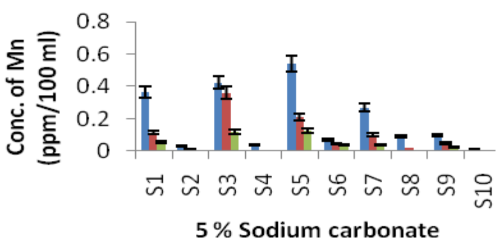

Figure 30

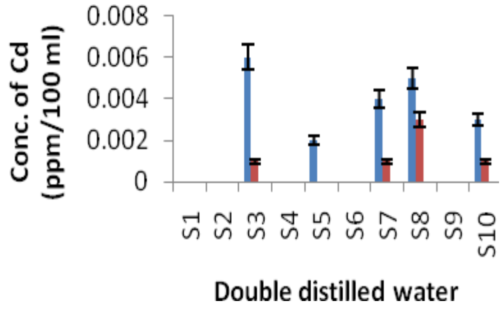

Figure 30

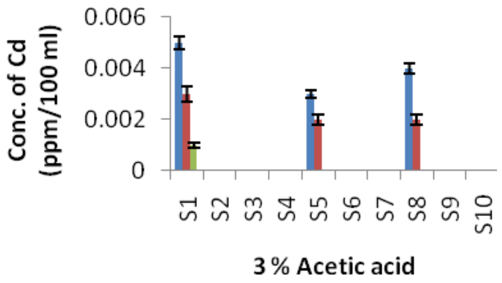

Figure 31

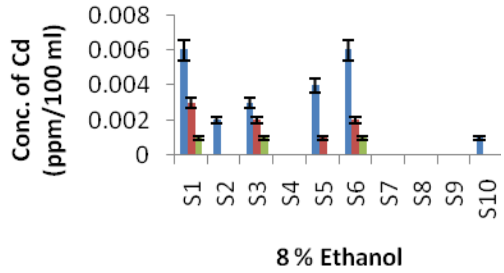

Figure 32

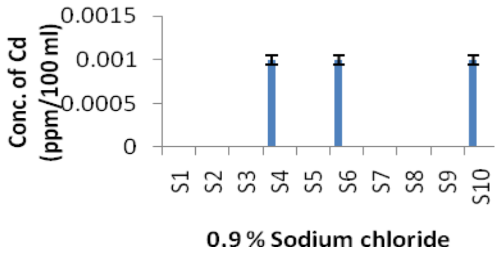

Figure 33

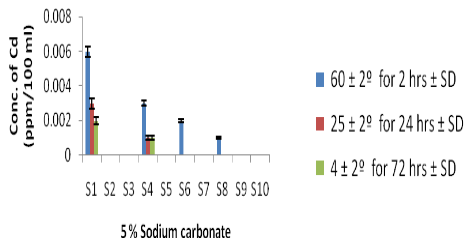

Figure 34

Figure 1-35: Shows the heavy metal migration in different simulating solvents and conditions.

4. Conclusion

The cups purchased from various areas of Lucknow, U.P. India contain toxic heavy metals in varying concentrations and most of them showing high concentrations that may pose hazards to human's as well as animal's health and create a major health hazard in its use and disposal especially at high temperatures.

Acknowledgment

All authors are thankful to our Hon'ble Vice Chancellor Prof. S.W.Akhtar for providing facilities. Authors are also thankful to Er Adnan habib, Mr Imran Khan and Mr Tanzeel Ahmad Khan for providing their help during experimental work.

5. REFERENCES

1. 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.
2. 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.
3. Bureau of Indian Standard. Positive list of constituents of styrene polymers in contact with food stuff, pharmaceuticals and drinking water, 1982: 10149.
4. Bureau of Indian Standards. Positive list of constituents of polypropylene and its copolymers in contact with food stuff, pharmaceuticals and drinking water, 1984: 10909.
5. 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.
6. The United States Pharmacopoeia: The National Formulary. USP-23. Untied State Pharmacopoeial Convention, Inc., 12601. Twinbrook Parkway, Rockville, MD 20852, 1995.
7. British Pharmacopoeia. Plastic containers for aqueous solutions for intravenous infusion. (Ph. Eur. Test 3.2.7) Appendix XIXC, 1998.
8. Bureau of Indian Standards. Glass fiber reinforced plastics pipes, joints and fittings for use for potable water supply — specifications, 1994 (12709).
9. US EPA Cadmium compounds factsheet, 2003.
10. 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.
11. Khaliqui MA, Alam MS and Srivastava SP. Implications of physico-chemical factors on the immigration of phthalate esters from tubing commonly used for oral / nasal feeding. Bull Environ Contam Toxicol., 1992; 48:572–578.
12. 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.
13. Figge K. Migration of additives from plastic films to edible oil and fat simulants. Food Cosmet Toxicol., 1977; 10: 815–827.
14. 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.
15. 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.
16. Jenke D. A general assessment of the physiochemical factors that influence leachables accumulation in pharmaceutical drug products and related solutions. PDA J Pharm Sci Technol.,2011; 65(2):166-76
17. Gallelli JF AND Groves MJ. USP perspectives on particle contamination of injectable products. J Parenter Sci Technol., 1993; 47:289-92.
18. Jenke D. Extractable/leachable substances from plastic materials used as pharmaceutical product containers /devices. PDA J Pharm Sci Technol., 2002; 56:332-71.
19. Jenke DR. Linking extractables and leachables in container/cloure applications. PDA J Pharm Sci Technol., 2005; 59:265-81.
20. Jenke DR, Jene JM, Poss M, Story J, Tsilipetros T and Odufu A. Accumulation of extractables in buffer solutions from a polyolefin plastic container. Int J Pharm., 2005; 297:120-33
21. Desai N, Shah SM, Koczone J, Vencl-Joncic M, Sisto C and Ludwig SA. Zinc content of commercial diluents widely used in drug admixture prepared for intravenous infusion. Inter J Pharm Compd., 2007; 11:426-32.

22. Chawla AS and Hinberg I. Leaching of plasticizers from and surface characterization of PVC blood platelet bags. Biomater Artif Cells Immobil biotechnol., 1991; 19:761-83.
23. Arbin A, Jacobsson S, Hanniene K, Hagman A, and Ostelius J. Studies on contamination of intravenous solution from PVC bags with dynamic headspace GC-MS and LC-diode array techniques. Inter J Pharm., 1986; 28:211-8
24. Cheung AP Hallock YF, Vishnuvajjala BR, Nguyenle T and Wang E. Compatibility and stability of bryostatin I in infusion devices. Invest New Drugs. 1998; 16:227-36.
25. Demore B, Vigneron J, Perrin A, Hoffman MA, and Hoffman M. Leaching of diethylhexyl Phthalate from polyvinyl chloride bags in to intravenous etoposide solution. J Clin Pharm Ther., 2002; 27:139-42.
26. Pearson SD and Trissel LA. Leaching of diethylhexyl Phthalate from polyvinyl chloride container by selected drugs and formulation components. Am J Hosp Pharm., 1993; 50:1405-9.
27. Ulsaker GA and Korsnes RM. Determination of cyclohexanone in intravenous solutions stored in PVC bags by gas chromatography. Analyst., 1977; 102:882-3
28. Gidlow DA. Lead toxicity. Occup Med., 2004; 54:76-81.
29. Needleman HL Bellinger D. The health effect of low level exposer to lead. Annu Rev Pub Health., 1991; 12:111-140.
30. 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.
31. 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.
32. 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