Toxic heavy metal contamination in locally made plastic food container

Saimah khan* , Abdul Rahman khan**.

Abstract— The exposure of human to toxic heavy metal release from plastic container creates a major health hazards. The main objectives of this study was to examine the concentration of toxic heavy metals (Pb, Cu, Ni, Zn, Mn, Cr and Cd) in local made food containers purchased from various districts of U.P,(India), at 25±2°C for 24hrs in different simulating solvents as per BIS, IP, USP and other guidelines by using atomic absorption spectrophotometer(AAS). The results found that leaching of heavy metals occur in all samples and showed the order: Pb(1.9-1.01ppm) in S1, S5, S4 > Cu(1.61-1.01ppm) in S4, S3, S5 > Ni(1.31-1.01ppm) in S3, S5, S2, S4 > Mn(1.01-1.001ppm) in S2, S4, S5 > Zn(1.002ppm) in S2.

Index Terms— Additives, Concentrations, Plastic containers, Health, Heavy metals, Leaching, Toxic.

1. INTRODUCTION

Plastic materials are remarkably resourceful and are used in variety of applications, but dominate in packaging. Plastic food containers are made from plastic polymers to which additives are added to attain certain desired properties for a definite application. Metals were added in order to improve the plastic features with light stabilizers, polymers or flame retarding agents[1,2]. These additives are not bounded chemically to the matrix of polymeric materials and leach out under the influence of several physico-chemical factors such as sunlight, temperature, type of solvents and also the pH of the stored commodity[3-10] and releases toxic substances to air, water, food, food simulants, saliva , sweat etc.

Various researches have been done on leaching of additives in the solution of plastic articles and found that concentration of heavy metal is above allowed limit [7,11]. Leaching of heavy metals such as Zn, Ni, Cu, Mn, Cd, and Pb from finished plastic products into the simulating solvents is hazardous to human health and can cause various health problems [12-16].

For proper use of plastic, guidelines have been formulated all over the world, BIS formulate the national standards[17-25]. Accordingly, the metal concentration should not be more than 1ppm except Cd should not be more than 0.1ppm. In this regard, the aim of this research were to determine the concentration of heavy metals which were above allowed limit in locally made food packaging containers purchased from various district of U.P, India.

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2. Material and methods

A total of 30 samples of five different brands of food containers used in the present study were purchased from various districts of U.P, India, for the assessment of heavy metals (Zn, Ni, Mn, Cu, Cr, Cd and Pb). All samples 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 samples were cut in a ratio of $1cm^2/2ml$ and were exposed in 100ml of each simulating solvents in sterile beakers. All the samples were kept at 25±2°C for 24 hours (ambient condition). For basal control, parallel sets having simulating solvents only were also run under identical conditions. The simulated sovents (100ml) were taken in a beaker and digested in a fuming chamber using concentrated nitric acid. The digested samples were scaled down 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 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.

3. Results and discussion

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

The mean concentration of Zn above allowed limit (1ppm) was found in S2 (1.002 ppm in 8% ethanol).

The mean concentration of Ni above allowed limit (1ppm) follows the order: S3(1.31 ppm in double distilled water) > S5(1.21ppm in double distilled water) > S2(1.102ppm in 8% ethanol) > S4(1.02ppm in 5% Na_2CO_3) > S2 and S3(1.01ppm in 3% acetic acid).

The mean concentration of Mn above allowed limit (1ppm) follows the order: S2 and S4(1.01 ppm in double distilled water and 0.9% NaCl) > S5(1.001 ppm in double distilled water).

The mean concentration of Cu above allowed limit (1ppm) follows the order: S4(1.61ppm in 3% acetic acid) > S3(1.36ppm in 0.9% NaCl) > S3(1.30ppm in 3% acetic acid) > S3 and S5(1.01 in double distilled water and 0.9% NaCl).

All samples were found to contain Cr under permissible limit. The highest mean concentration of Cr(0.11ppm) was detected in case of double distilled water.

Cd was found under permissible limit(0.1ppm) in few samples.

The mean concentration of Pb above allowed limit(1ppm) follows the order: S1(1.9ppm in double distilled water) > S5(1.2ppm in 8% ethanol) > S4(1.04ppm 5% Na_2CO_3) > S1(1.029ppm in 0.9% NaCl) > S1(1.01ppm in 5% Na_2CO_3).

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

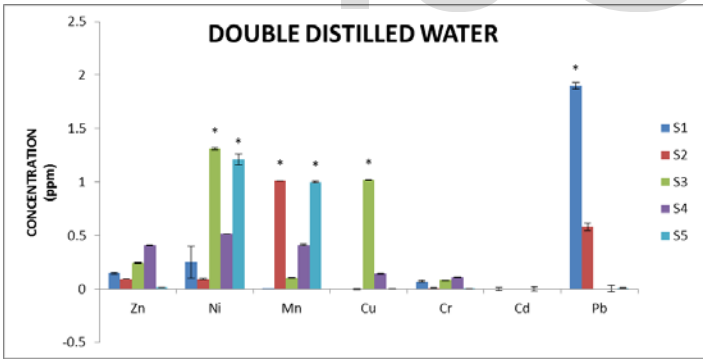

Figure-1: The concentration of metals (ppm) in double distilled water at 25±2˚C for 24 hrs.

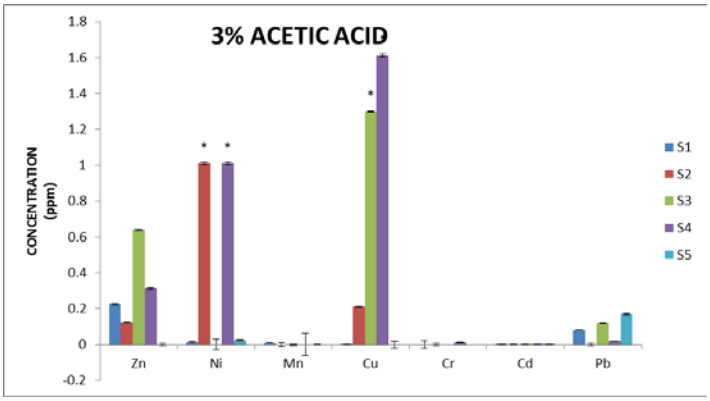

Figure-2: The concentration of metals (ppm) in 3% Acetic acid at 25±2˚C for 24 hrs.

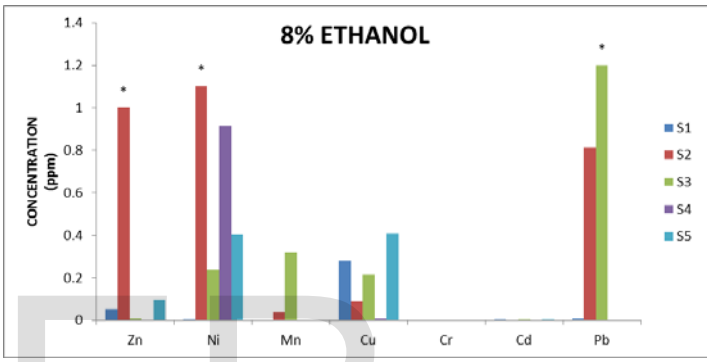

Figure-3: The concentration of metals (ppm) in 8% Ethanol at 25±2˚C for 24 hrs.

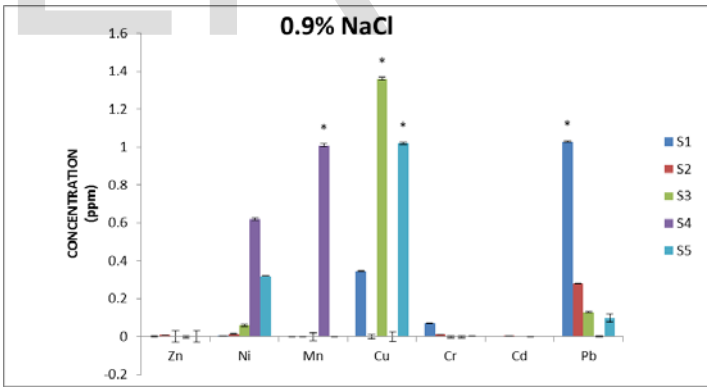

Figure-4: The concentration of metals (ppm) in 0.9% NaCl at 25±2˚C for 24 hrs.

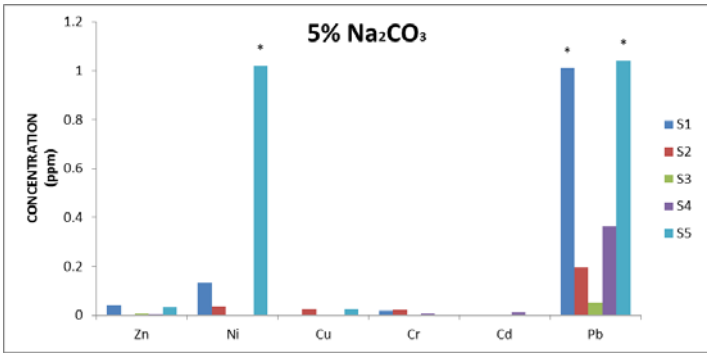

Figure-5: The concentration of metals (ppm) in 5% Na_2CO_3 at 25±2˚C for 24 hrs.

4 CONCLUSION

This report documented the human exposure to toxic heavy metals in packaging. 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, Mn, Zn 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.

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