Studies on Lead Extraction From Glazed Pottery Under Different Conditions

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Many cases of lead poisoning reported each year are caused by products commonly available in the house. An insidious source of lead is glazed earthenware pottery. Lead compounds have long been used for glazing pottery since they impart low surface tension and low viscosity over a wide temperature range which results in greater smoothness, lustre and brilliance in the glaze. Lead poisoning cases resulting from the consumption of acidic beverages stored in glazed pottery have been reported from Pakistan (1), Japan (2), Mexico (3) and Yugoslavia (4).

In view of the increasing popularity of glazed pottery in India, an investigation was carried out to study the amount of lead extracted from the pottery under different conditions.

MATERIALS AND METHODS

Samples - Two hundred and thirty one samples of earthenware pottery of unknown glaze composition were randomly selected from the local market.

Equipment

a) UNICAM SP 500 spectrophotometer.
b) Corning glassware was used after removal of lead by acid treatment.

Reagents - Analytical grade reagents and double glass distilled water were used.

Method

Pottery samples were washed, filled to the brim with 4% acetic acid solution and the volume was recorded. The samples were covered with polythene film and kept at room temperature for 24 hours. 5 ml of this solution was taken for lead estimation by a Dithizone method (5). To see the effect of temperature on the leaching of lead, glazed mugs were filled with 4% acetic acid solution and kept at 30°, 50°, 70°, 80°

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and 90°C for six hours. The volumes of the solutions were made up to the initial values with 4% acetic acid solution to compensate for evaporation losses and lead was estimated as above (5).

RESULTS

Table 1 shows that the acid extract had a lead content between 1.0 - 2.0 mg/litre in 4 mugs and between 2.0 - 2.5 mg/litre in 13 mugs. The majority of the mugs (204 out of 231) contained between 2.5 - 6.0 mg/litre. Only 10 mugs had a lead content between 6.0 - 6.5 mg/litre. The mean concentration of lead in all the samples was 4.2 mg/litre.

Table - 1

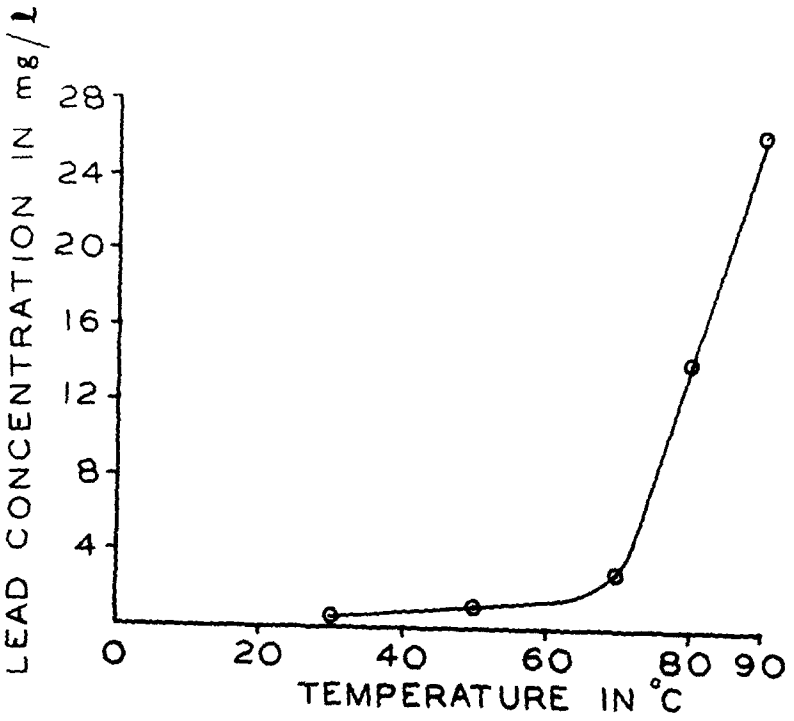
Lead concentration in 4% acetic acid extract after storing the solution in glazed earthenware mugs for 24 hours at room temperature (30°C)

Concentration of lead in mg/litre	Mugs	
	Numbers	Percentage
Between 1 and 2	4	1.73
" 2 - 2.5	13	5.63
" 2.5 - 3.0	28	12.12
" 3.0 - 3.5	32	13.85
" 3.5 - 4.0	22	9.53
" 4.0 - 4.5	25	10.82
" 4.5 - 5.0	39	16.88
" 5.0 - 5.5	35	15.15
" 5.5 - 6.0	23	9.96
" 6.0 - 6.5	10	4.33
Total	231	100.00

Figure 1 shows that acidic solutions stored in glazed pottery samples leached out a small amount of lead at room temperature. The amount of lead leached out was gradual up to 70°C but increased sharply between 70°C and 90°C. No significant amount of lead was found

in water kept under the same conditions. This clearly indicates that storing acidic solutions at high temperatures increased the amount of lead extracted significantly.

Fig. 1



Effect of temperature on the extraction of lead by 4% acetic acid in six hours from pottery

Repeated extractions from the same sample showed that the amount of the metal leached out decreases with each successive extraction (Table 2). The fifth extraction was found to contain about one tenth of the amount present in the first extraction.

Table - 2

Concentration of lead in the first and fifth 4% acetic acid extract

Sample No.	Lead concentration in first extraction mg/litre	Lead concentration in fifth extraction mg/litre	Ratio of first to fifth extraction
1	5.15	0.50	10.30
2	4.0	0.42	9.52
3	4.85	0.43	11.27
4	4.85	0.46	10.54
5	3.55	0.34	10.44
6	3.42	0.38	9.00

DISCUSSION

Cases of poisoning by the consumption of acidic food or drink from glazed utensils have been reported since the 18th century. Lead was abundantly used in the Roman Empire to glaze cooking vessels as well as to adulterate wine (6,7).

Recently many cases of lead poisoning from the use of pottery have been reported from all over the world (8,9,10). Leonard and Lynch reported that certain tableware from Japan had a high lead content (2). In Yugoslavia 40 people were poisoned from the use of earthenware pots (4). In 1969 five members of a family were poisoned by Mexican pottery (3), while glazed earthenware in Pakistan was found to yield lead after extraction with citric acid (1). In an investigation of cooking vessels it was found that food cooked in lead glazed earthenware might take up from 3 to 4 parts per million, and hot dilute citric acid solution allowed to simmer in these vessels for half an hour took up as much as 80 parts per million of the metal(10). In Germany glazes are condemned if they yield soluble lead on being heated for half an hour with 4% citric acid (10). Kehoe has shown by an experiment on human subjects that the daily intake of 3 mg of lead in

addition to that present in the normal diet would reach the point of danger in approximately eight months (11).

In the present investigation the maximum amount of lead found in the acetic acid solution was 6.5 mg/litre which is slightly less than the limit of 7 mg/litre defined by the United States Food and Drug Administration as the maximum lead release of glazes recommended for use on ceramic items intended for food and drink (12). As lead is a cumulative poison the continuous use of such pottery over a long period of time could pose a health hazard. The sharp increase in the amount of lead extracted between 70° and 90°C indicates that regular consumption of hot acidic solutions from glazed pottery is likely to lead to plumbism.

SUMMARY

An investigation was carried out to estimate the amount of lead extracted by storing acetic acid in 231 pieces of glazed earthenware pottery. The average concentration of lead was found to be 4.2 mg/litre and the range was 1.0 to 6.5 mg/litre. The amount of lead extracted increased sharply between 70° to 90°C. Hence storage of hot beverages in pottery for long periods may pose health hazards due to chronic lead toxicity.

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REFERENCES

1. Ahmad, S., Haq, A., and Faruqui, F.A. "Toxic Properties of Indigenous Earthenware" Pakistan J. Sci. 16: 9-44, 1964.

2. Leonard, A., Lynch, G. "Dishware as a Possible Source of Lead Poisoning". Calif. Med. 89: 414-416, 1958.

3. Block, J.L. "The Accident that Saved Five Lives". Good Housekeeping 169: 60-70, 1969.

4. Beritic, T., and Stahuljak, D. Lead Poisoning from Lead Glazed Pottery". Lancet 1: 669 March 25, 1961.

5. Chemical Services Dept. U.K.: Atomic Energy Authority (U.K. A.E.A. Risely, Warrington, England) U.K. A.E.A. Report (G.O.-A.M/W-169) 1958, 7 pp.

6. Gilfillan, S.C. "Lead Poisoning and the Fall of Rome". J. Occup. Med. 7: 53-60, 1965.

7. Whitehead, T.P. and Prior, A.P. "Lead Poisoning from Homemade Wine". Lancet 2: 1343-44 (Dec) 1960.

8. Klein, M., Namer, R., Harpur, E. and Carhin, R. "Earthenware Containers as a Source of Fatal Lead Poisoning". The New Eng. J. Med., 283: 669, 1970.

9. "Some Pottery Lead Glazes". California's Health, Feb. 1971, 28-8.

10. Harris, R.W. and Elsea, W.R. "Ceramic Glaze as a Source of Lead Poisoning". J. Amer. Med. Assoc. 202: 544, 1967.

11. Kehoe, R.A. "Metabolism of Lead Under Abnormal Conditions". Arch. Environ. Health. 8: 235-243, 1964.

12. Ceramic Industry. 94: 6, March 1970 (Newsletter).