Occurrence of Lead in Sesame Paste and Factors Responsible for It

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ABSTRACT

Sesame paste was found to contain a relatively high concentration of lead (approximately 2.2 p.p.m.). Since storage in unlacquered cans, including an additional short-term test at 35° C., did not result in an increase over the initial level (found in paste from the same batch stored in polyethylene jars), the conclusion is that the above high figure is due not to migration of the metal present in the packaging material, but rather to an original high content in the oilseeds, as found in samples from three countries.

The significance of lead as an environmental contaminant, and its potential hazard to man, have been comprehensively reviewed (1,2). Since, apart from occupational and accidental exposure, normal food and beverages are the most important sources of daily exposure (3) (average daily intake of lead, between 0.0033 and 0.0050 mg. per kg. body weight, as against approximately 0.0013 mg. from the atmosphere in an urban environment) (4), they must be kept under control at least as strictly as air pollution by motor vehicles or industry. In view of the wide variability of the lead content of different foods (2), it is important to find out which items are the main contributors to the lead content of the diet.

Occasional analyses carried out on foods containing sesame paste revealed a relatively high concentration of lead. In the study reported here, a larger number of samples were analyzed, with a view to checking earlier observations and finding possible reasons for the high lead levels.

MATERIALS AND METHODS

Materials

Sesame paste stored in unlacquered cans and high-density polyethylene jars, and sesame seeds of different origins, were purchased from the same factory and sampled at random. Some of the cans, each containing 100 g. paste, were stored at 35°C. for 2 months with a view to accelerated corrosion and, possibly, to migration of the lead from the solder in the side seam of the cans.

Analytical Procedure

Twenty-five-gram aliquots—at least two from each sample—were placed in porcelain crucibles, heated mildly in a sand bath for several hours, and then dry-ashed in a muffle furnace overnight at 550°C. The ash was boiled in a flask containing 50 ml. of 1N HCl, under reflux, for 15 min., and the solution filtered through acid-washed filter paper and boiled to dryness. Finally, the residue was redissolved in 10 ml. of 1N HCl.

The lead content of the final solution was determined by atomic-absorption spectrophotometry. A Zeiss PMQII spectrophotometer (with a monochromator, Model M4QIII), equipped with a flame attachment (Model FA2), and a hollow cathode lamp for lead (Cat. No. 506134) was used. The operating parameters were as follows: wavelength, 217.0 nm.; slit width, 0.2 mm.; source current, 15 ma.; flame, a nonluminous air-acetylene mixture (flow rates, 70 and 35 scale divisions, respectively).

The lead contents of the test aliquots were calculated from a calibration graph (linear within the 0 to 50 p.p.m. range) obtained—for each assay series—with standard lead solutions prepared from dried analytical reagent grade lead nitrate, dissolved in 1N HCl, with 1N HCl solution used as blank. All standard solutions were kept in containers made of polyethylene, in order to prevent the drop in absorbance observed in the more dilute solutions (10 p.p.m. or less) on storage in glass bottles (about 10% after 7 days at room temperature), and apparently due to adsorption of the lead on the walls of the container (5). The possible interference by as much as 10,000 p.p.m. of calcium, phosphorus, potassium, and sodium under the conditions mentioned above was checked and found to be negligible.

RESULTS

Preliminary experiments showed that lead added to sesame could never be fully recovered, probably because of losses during the analysis. Table I summarizes an experiment run under the conditions reported above. A solution containing 37.5 γ of lead was added to 25-g. aliquots of sesame seeds of a known lead content (1.7 p.p.m.) before ashing. All figures calculated from the calibration graph were corrected accordingly, and the final values are listed in Table II.

The sesame paste stored in cans did not significantly differ in its lead content from that stored in polyethylene jars (as proved by a t-test); not even additional short-term storage of the cans at a higher temperature resulted in an increase. Likewise, the differences in lead content between the sesame seeds from the different sources were statistically insignificant, nor was any change caused by decortication.

TABLE I. RECOVERY OF LEAD ADDED TO SESAME BEFORE ASHING

Aliquot No.	Recovery (%)
1	79
2	85
3	81
4	83
Average	82

DISCUSSION

Several studies have been conducted on lead contamination of foodstuffs during storage in cans. Schroeder and Balassa (6) suggested that a small amount of lead may enter some foods from the solder used in the manufacture of cans. The alloy used almost everywhere today for outside soldering of the side seam of the can body contains 98% lead. Whatever the type of can, the meniscus of the solder inevitably (albeit at a very small area) comes in contact with the stored product (7), unless the side seam is lacquered after the can is assembled. Bergner and Miethke (8), in tests on applesauce cans, found that the side seam contributed 0.1 to 0.5 mg. lead per kg. of stored product. In the present study, however, storage in unlacquered cans failed to produce an increase in lead content compared with storage in polyethylene jars, apparently because sesame paste is a less corrosive medium than applesauce.

TABLE II. LEAD CONTENT (p.p.m.) OF SESAME PASTE AND SEEDS

Material	Sample No. 1	2	3	4	5	6	Average	Standard Error
Sesame paste in cans	2.0	2.2	2.4	2.2	2.4	2.4	2.27	0.06
Sesame paste in cans after 2 months' storage at 35°C.	2.2	2.0	2.1	2.2	...	...	2.13	0.08
Sesame paste in polyethylene jars	1.8	2.4	2.7	2.2	...	...	2.28	0.17
Ethiopian sesame seeds, decorticated	2.2	1.4	1.6	2.2	1.4	...	1.76	0.18
Ethiopian sesame seeds, whole[a]	1.6	1.7	1.8	1.3	1.6	2.2	1.70	0.12
Tanzanian sesame seeds, whole	1.8	1.4	1.4	1.6	...	...	1.55	0.10
Local sesame seeds, whole	1.8	1.8	1.6	1.9	1.6	...	1.74	0.06

[a]All decorticated and whole Ethiopian sesame seed samples were from the same batch.

Since all the equipment used in the manufacture of sesame paste at the factory in question is made of stainless steel with lead-free welded joints, neither the manufacturing process nor the storage facilities could be blamed for the lead in the product. The only likely source was thus the raw material, namely the oilseeds. This conclusion was later confirmed when all seed samples assayed, irrespective of origin, showed a relatively high lead content.

The more important factors likely to affect the lead content of crops are its concentration in the soil, use of lead-containing insecticides on crops, and contamination through aerial fallout (9).

With regard to the soil, crops grown in soils with a high lead content are known to accumulate much more of the metal than those grown in lead-poor ones (3). In our case, although the exact localities where our sesame samples were grown are unknown, it seems very unlikely that all of them, in all three different countries, are exceptionally rich in lead.

Although lead-containing insecticides (such as lead arsenate) were widely used in the past, they are today restricted to specialized problems (3). But even if they were used on the crops in question, one would expect that the plant tissues to which the insecticide had been directly applied would contain a higher level of lead compared with the inner tissues. This would also be the case if air pollution, from motor vehicle exhaust gases or industries, were the cause for the high lead content of the crops. It was found, in fact, that air-exposed tissues from plants grown within 300 yards of heavily traveled highways, or otherwise subjected to lead pollution, contained much more lead than the inner tissues, or tissues grown below the soil surface (10). (For example, tops of carrot and potato were compared with their respective roots and tubers, and leaves of cauliflower and rhubarb were compared with their hearts and stems, respectively.) Bovay (11), too, claimed that aerial lead contamination of vegetation was superficial. In this study, however, the lead contents of whole and decorticated sesame grains from the same origin and batch were approximately the same.

Our conclusion is, therefore, that the sesame plant has an unusual capacity for lead accumulation from the soil in the seeds and perhaps in other parts as well.

The lead content of the sesame paste was somewhat higher than that of the seeds. This may be because some of the oil present in the seeds separates during the rolling and grinding process and subsequent storage of the paste, whereas all the lead remains in the paste and thereby becomes more concentrated.

The maximum acceptable load of lead from food set by FAO/WHO Expert Committee on Food Additives is 0.005 mg. per kg. body weight per day (4). Accordingly, the consumption limit of foods containing more than 2 p.p.m. of lead is below 175 g. per day for an adult weighing 70 kg. This conclusion is particularly crucial for certain populations in the Orient and Africa, for whom sesame paste is a staple food.

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