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Mineral Elements in Canned Spanish Liver Paté

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ABSTRACT

The contents of lead, cadmium, copper, iron and zinc were determined by atomic absorption spectrophotometry in 30 samples of canned liver paté. Each sample was divided into five portions based on their contact with a specific part of the container. Statistically significant differences ($p < 0{\cdot}001$) were found to exist among the brands for all the minerals and among the portions only in the case of lead. The differences in the concentration of lead between the portion nearest to the solder on the side flap ($X = 2{\cdot}43$ mg/kg) and the rest of the portions ($X = 1{\cdot}03$ mg/kg) were statistically significant ($p < 0{\cdot}001$). However, the differences observed for cadmium, copper, iron and zinc are not significant ($p < 0{\cdot}05$). The concentration levels were compared to literature data and the influence of the solder as a lead contaminator was shown.

INTRODUCTION

The presence of mineral elements in foodstuffs depends, among other numerous factors, on the technological practices of production and manufacture (Ybañez, *et al.*, 1982). Some of these minerals such as copper, iron and zinc are essential to man (Underwood, 1971) and others, on the contrary, such as lead and cadmium, create serious problems because of their tried toxicity in the human organism (Reilly, 1980). Furthermore, it is undoubtedly the liver that, for its biological function, is the organ in which the mineral concentrations will be highest (Palacios & Ramirez, 1979).

One characteristic to be desired in food containers is that they should be

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inert, i.e. that no reactions of interchange between the foodstuff and the container should be established. At present the tinplate used in conserves is hygienically safe to an acceptable degree although possibly the solder of the flaps is the most problematic area of the container.

The objective of this work was to study the changes that can (due to canning) occur in the concentrations of copper, iron, zinc, lead and cadmium in canned liver paté.

MATERIAL AND METHODS

Three commercial brands of liver paté canned in varnished tinplate with tin side solder were analysed. The canned samples, with net contents of 190 g, were kept at room temperature until their analysis, which was carried out 6 months from their manufacture. Ten cans of each brand were tested; each one was opened and divided into five portions, (1) next to the solder, (2) next to the lids, (3) in contact with the tinplate and at a distance from the solder and (4) and (5) two interior portions.

AOAC methods (Association of Official Analytical Chemists, 1980) were used with certain modifications to suit the type of sample. Ten grams of each one of the portions was dried at temperatures below 100°C for approximately 2 h. Subsequently, the temperature was raised gradually, to avoid losses from splashing, until the smoke ceased. The dried sample portions were mineralised by oven-drying overnight, not going above 450°C. Afterwards, 10 drops of deionised water and 5 ml of nitric acid solution 1:1 (v/v) were added, and the samples kept on a thermostatic plate until desiccation. Once desiccated they were again placed in the oven at 450°C for 1 h. The ashes were collected with repeated additions of 5 ml of hydrochloric acid solution 1:1 (v/v) making up its volume to 25 ml with deionised water. This volume was transferred to polyethylene tubes until the time of analysis.

The determinations were performed with a Perkin-Elmer Model 2380 Atomic Absorption Spectrophotometer. A 10 cm 1-slot burner head and standard air–acetylene flame, and wavelengths of 283·3, 228·8, 324·8, 248·3 and 213·9 nm for lead, cadmium, copper, iron and zinc, respectively, were used. Simple element hollow cathode lamps were used for all elements. The instrument settings and other experimental conditions were in accordance with the manufacturer's specifications. The sensitivity obtained was 0·27, 0·016, 0·095, 0·123 and 0·020 mg/litre for lead, cadmium, copper, iron and zinc, respectively. The mean recoveries for the lead and cadmium were 90% and 104%, respectively. For the calculation of the detection limit the criteria of the American Chemical Society (1980) and Mottola (1984) were followed. The concentration limits obtained (minimum concentrations detectable in fresh weight) were 0·093, 0·006, 0·027, 0·068 and 0·009 mg/kg for lead, cadmium, copper, iron and zinc, respectively. Data obtained from the chemical analyses of the samples were evaluated statistically using Model I and repeated measures analysis of variance (Sokal & Rohlf, 1969).

RESULTS AND DISCUSSION

The results obtained are listed in Table 1. By means of a two-factor analysis of variance the existence of statistically significant differences ($p < 0{\cdot}01$) in the concentrations of cadmium, copper, iron and zinc among the three brands chosen were observed. However, no statistically significant differences ($p < 0{\cdot}05$) between the different portions established were observed. In the case of lead a different situation is noted since there are no differences among the brands ($p < 0{\cdot}05$) but differences do exist between portions ($p < 0{\cdot}001$). On carrying out a more detailed study of the irregular behaviour of lead, it was seen by means of a one-factor analysis of variance, taking each of the portions established, that statistically significant differences ($p < 0{\cdot}001$) existed among brands except in the portion in contact with the side solder. This is probably due to the high variability found in this portion (RSD = 162·36%) which has a decisive influence on the correlation coefficient obtained when considering all the portions together.

With respect to the differences observed among the portions, it was noticed that there were no statistically significant differences ($p < 0{\cdot}05$) in

TABLE 1
Concentration of Elements ($\bar{X}$ ± SD) in Canned Liver Paté[a]

	Portions	Pb	Cd	Cu	Fe	Zn
Brand A	1	1·56 ± 1·75	0·134 ± 0·017	8·32 ± 2·76	63·3 ± 7·4	24·25 ± 1·96
	2	0·74 ± 0·33	0·138 ± 0·017	8·50 ± 2·69	58·8 ± 6·5	28·69 ± 2·01
	3	0·64 ± 0·25	0·132 ± 0·016	8·22 ± 2·86	58·5 ± 6·3	23·62 ± 0·79
	4	0·56 ± 0·21	0·132 ± 0·014	8·63 ± 2·76	56·5 ± 5·9	23·50 ± 1·55
	5	0·55 ± 0·22	0·132 ± 0·016	8·18 ± 2·72	57·4 ± 6·9	24·08 ± 1·88
Brand B	1	2·13 ± 0·99	0·148 ± 0·070	6·08 ± 0·96	38·8 ± 5·5	13·51 ± 2·28
	2	1·52 ± 0·47	0·147 ± 0·070	6·38 ± 0·86	39·0 ± 5·3	13·53 ± 1·91
	3	1·55 ± 0·53	0·148 ± 0·072	6·70 ± 1·74	38·6 ± 4·9	13·59 ± 2·51
	4	1·46 ± 0·47	0·144 ± 0·069	5·56 ± 0·84	36·7 ± 2·8	12·31 ± 1·11
	5	1·44 ± 0·48	0·147 ± 0·070	5·88 ± 0·83	37·9 ± 4·3	12·87 ± 1·08
Brand C	1	3·60 ± 6·36	0·092 ± 0·045	4·88 ± 0·23	28·2 ± 8·7	10·50 ± 0·88
	2	1·06 ± 0·24	0·094 ± 0·044	4·99 ± 0·32	22·0 ± 4·8	10·83 ± 1·00
	3	1·03 ± 0·27	0·094 ± 0·043	5·12 ± 0·31	28·9 ± 8·8	10·95 ± 1·96
	4	0·97 ± 0·23	0·092 ± 0·036	4·72 ± 0·27	23·3 ± 5·4	11·71 ± 2·12
	5	1·00 ± 0·27	0·093 ± 0·046	4·67 ± 0·33	21·1 ± 4·8	10·99 ± 0·94

[a] mg/kg in fresh weight.

lead concentrations among the portions which were not in contact with the solder. However, highly significant differences ($p < 0{\cdot}001$) were found between the portion in contact with the solder and the rest of the portions. The high mean content of lead in this portion (2·43 mg/kg) in comparison with the rest of the portions (1·03 mg/kg) is notable. It can conclusively be deduced that the high levels of lead found in this portion are due to a parting of the container in the area of its solder. Thus, Ybañez *et al.* (1982) indicated that the seepage of lead in liver patés canned in tinplate with tin solder in the side flap can reach concentrations of up to 61·9 mg/kg in the portions nearest to the tin solder. The maximum level found by us in this portion was 22·59 mg/kg.

Furthermore, we have already pointed out the high variability in the content of lead in the portion nearest to the solder (RSD = 162·36%) in comparison with the rest of the portions (RSD = 49·26%). In these last portions the levels found are in accordance with a normal distribution (Fig. 1) resembling the type described by Sanchez Saez *et al.* (1981) for non-canned products. This normal distribution is not found for the levels of lead in the portion in contact with the solder and resembles the distribution described by Sanchez Saez *et al.* (1981) for canned products. For the first group it is deduced that the levels of lead found originate in the actual raw material and for the second group they originate in a contamination coming from the tin in the side flap of the container. The levels of lead found in the samples analysed are slightly higher than those obtained by other authors in this product (Angelucci, 1978; Ybañez *et al.*, 1982; Brito *et al.*, 1987).

As for the rest of the minerals studied (cadmium, iron, copper and zinc) a

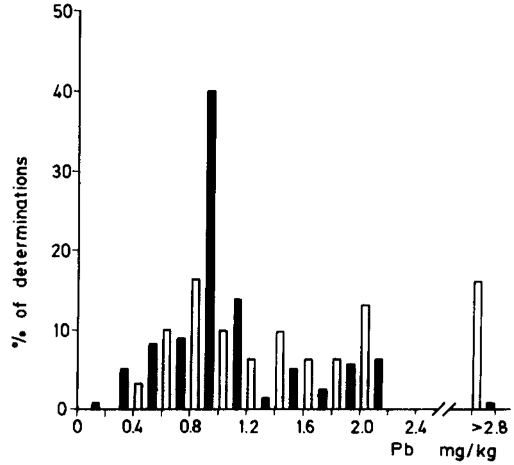

Fig. 1. Distribution of percentage frequencies of the lead content (mg/kg) in fresh weight. □, Portion nearest to solder; ■ rest of the portions.

study was also made of the variability among brands and portions, and statistically significant differences were found between brands ($p < 0.001$) but not between portions ($p > 0.05$). The levels of cadmium found are higher than those obtained by other authors (Nuurtamo *et al.*, 1980; Ybañez *et al.*, 1982; Brito *et al.*, 1987). The concentrations of copper, iron and zinc are similar to those found by other authors (Angelucci, 1978; Nuurtamo *et al.*, 1980; Ybañez *et al.*, 1982, 1983; Brito *et al.*, 1987).

On carrying out a study of correlations among the minerals analysed, highly significant correlations ($p < 0.001$) were observed between the concentrations of copper, iron and zinc, probably due to their similar origin as components of the raw material of the product. However, no significant correlations between these three minerals and the cadmium were found since cadmium is found in these products as a contaminator and the others are intrinsic components of the raw material. We have also found positive correlations ($p < 0.001$) between lead and cadmium in those portions which were not in contact with the solder. However, the ($p > 0.05$) correlation was not found in the portion in contact with the solder, due, logically, to the contribution of lead from the solder.

Estimates carried out in Spain as regards the average consumption of these products per person/day are 0·69 g of the average food ration of 1387 g (Instituto Nacional de Estadistica, 1985). If we take into account the mean level of Pb obtained (1·32 mg/kg), the contribution of Pb will be 0·91 μg/day. The majority of the estimates made in various countries suggest that the dietary intakes for lead in adults, oscillates between 54 μg/day (Dabeka *et al.*, 1987) for Canada, 95 μg/day (Gartrell *et al.*, 1985) for the US, to 412 μg/day (Dick *et al.*, 1978) for New Zealand. The estimate of dietary intakes for lead in young children is 26 μg/day (Smart *et al.*, 1987) in the UK. A rational consumption of these products does not imply any health risk for adults. However, it is obvious that an increase in consumption of these products could signify a health risk since the FAO/WHO provisional tolerated daily intake is 7·1 μg/kg (Codex Alimentarius Commission, 1984). The Joint FAO/WHO Expert Committees on Food Additives recently recommended (World Health Organization, 1987) a provisional tolerable weekly intake for lead of 25 μg/kg body weight/week for infants and young children. The health risk increases in children as apart from a greater consumption of these products by them, their gastro-intestinal absorption is higher than that of adults.

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