CLI. THE INFLUENCE OF CERTAIN CONSTITUENTS OF THE DIET UPON THE ABSORPTION OF LEAD FROM THE ALIMENTARY TRACT

BY SIDNEY LIONEL TOMPSETT

*From the Biochemical Laboratory, Department of Pathology,
Royal Infirmary, Glasgow*

(Received 22 June 1939)

LEAD may be absorbed from the respiratory tract, from the alimentary tract and from the skin. In industrial Pb poisoning, absorption from the respiratory tract is usually the important factor. In the "normal" hazard, absorption is chiefly from the alimentary tract. This at times may be largely due to contamination of foodstuffs and drinking water with undue amounts of Pb. The object of the experiments to be described was to see whether variation in the composition of the diet had any influence upon the absorption of Pb from the alimentary tract.

Aub *et al.* [1926] compared the degrees of absorption of Pb in two groups of cats, one group being on a milk diet and the other on a milk-free diet. They could detect no marked difference in the amounts of Pb absorbed by the two groups and concluded that the amounts of Ca in the diet had no influence upon the amount of lead absorbed from the alimentary tract. Sobel *et al.* [1938], in a study of experimental Pb poisoning in rats, found that about twice as much Pb was absorbed on a diet containing viosterol as without it.

EXPERIMENTAL

Adult male mice were the animals used throughout this work. Two basic diets were used, namely a low Ca diet and a high Ca diet, of the following compositions.

<i>Low Ca diet</i>		<i>High Ca diet</i>	
Shelling [1932]			
	g.		g.
Whole wheat flour	400	Whole wheat flour	700
Casein	100	Whole milk powder	300
Corn starch	325	Marmite	50
Wheat gluten	50		
Olive oil	40		
NaCl	20		
KCl	15		
Butter	Omitted		

In the first series of experiments, the effects of high and low Ca diets upon the absorption of Pb were studied.

The mice were fed with the specified diets (2.5 g. per mouse per day), to which were added supplements of Pb in the form of lead acetate solution. Each mouse was housed in a separate glass jar, which was floored with sawdust. No restriction upon the amount of water drunk was made. The amount of diet supplied was constant per mouse per day. The diet together with the Pb supplements was made up into a thick paste with water and supplied in a porcelain dish, thus minimizing loss due to spillage. No difficulty was experienced in obtaining complete consumption of the daily diets by the mice. The experimental period was 14 days. At the end of this period, the jars were cleaned out and the animals placed upon the high Ca diet for 4 days to remove unabsorbed Pb from their alimentary tracts. The animals were then killed and the Pb content of the whole animal determined by the method published previously [Tompsett & Anderson, 1935; Tompsett, 1939]. The Pb content of control animals and also that of unsupplemented diets were determined.

It was found that absorption of Pb was not very marked with the high Ca diet but was high upon the low Ca diet. In the latter case, absorption increased with increase in the amount of added Pb.

Table I. *Experimental period, 14 days*

The results are expressed as (A) mg. total Pb, (B) mg. Pb per 100 g. body wt.

Supplement of Pb (mg. Pb per mouse per day)	0.05		0.10		0.50		1.00	
	A	B	A	B	A	B	A	B
Low Ca diet								
Exp. 1	0.046	0.224	0.159	0.795	0.254	1.270	0.445	2.42
2	0.143	0.681	0.211	1.055	0.510	2.55	0.909	5.05
3	0.057	0.259	0.149	0.709	0.200	0.87	0.385	1.68
4	0.133	0.665	0.182	0.867	0.450	2.37	0.666	1.33
Average		0.457		0.856		1.76		2.63
High Ca diet								
Exp. 5	0.033	0.173	0.042	0.210	0.055	0.282	0.057	0.317
6	0.042	0.221	0.054	0.284	0.042	0.200	0.050	0.217
Average		0.197		0.247		0.241		0.267
Low Ca diet + Ca glycerophosphate (high Ca diet)								
Exp. 7	0.027	0.142	0.028	0.155	0.029	0.129	0.028	0.143
8	0.026	0.108	0.027	0.117	0.030	0.115	0.036	0.180
Average		0.125		0.136		0.122		0.162
Low Ca diet + olive oil								
Exp. 9	0.133	0.633	0.182	0.860	0.250	1.25	0.366	1.74
10	0.125	0.571	0.252	1.200	0.714	3.10	0.833	3.97
Average		0.602		1.030		2.18		2.86
Low Ca diet + cod liver oil								
Exp. 11	0.128	0.609	0.222	0.925	0.714	3.10	0.800	4.21
12	0.133	0.665	0.159	0.757	0.360	2.00	0.500	2.63
Average		0.637		0.841		2.55		3.42
High Ca diet + cod liver oil								
Exp. 13	0.029	0.132	0.040	0.167	0.046	0.230	0.054	0.135

Pb content of control animals = 0.020 ± 0.003 mg. Pb.

Pb content of the high Ca diet = 0.002 mg. Pb per mouse per day.

Pb content of the low Ca diet = 0.002 mg. Pb per mouse per day.

In view of this, experiments were then carried out in which mice were fed with low Ca diet containing added supplements of Pb, to which had been added Ca glycerophosphate (0.5 g. per mouse per day). This in effect converted the low Ca diet into a high Ca diet. Here again the effect of the high Ca diet was to produce only a small absorption of Pb.

The effects of fat and vitamin D upon the absorption of Pb were then studied. It was considered that fat might hinder the absorption of Pb by the formation of insoluble Pb soaps. In this series of experiments, the mice were placed upon the low Ca diet, containing supplements of added Pb to which was added olive oil at the rate of 1 ml. per mouse per day. No specific influence of fat upon the absorption of Pb could be detected. It was considered that vitamin D might aid the absorption of Pb in the same way as it assists the absorption of Ca. In this series of experiments the mice were placed on (a) the high Ca diet, (b) the low Ca diet containing supplements of added Pb, to which was added cod liver oil at the rate of 3 drops per mouse per day. The experimental results obtained did not indicate any marked influence by vitamin D upon the absorption of Pb.

The results obtained are shown in Table I.

DISCUSSION

Examination of the influence of variation in the concentration of certain constituents of the diet upon the absorption of Pb from the alimentary tract in mice has shown that from a high Ca diet the absorption of Pb was small and was not influenced to any great extent by the amount of Pb administered. Upon a low Ca diet, the amount of Pb absorbed was large and depended to a large extent upon the amount of Pb administered.

It is interesting to speculate as to the reasons for this. According to Shields *et al.* [1938], absorption does not take place from the stomach but takes place rapidly from the small intestine. The phosphate content of both diets is high and as a result the Pb will be chiefly present as Pb phosphate. The solubility of this Pb phosphate in the intestinal contents, and hence its capacity to be absorbed, will depend to a great extent upon the reaction of the intestinal contents. It is suggested that upon the low Ca diet, the reaction of the intestinal contents tend to become more acid whereas on the high Ca diet the contents tend to become more alkaline.

Although large amounts of Pb were absorbed on a low Ca diet, the absorption by animals receiving the same quantities of Pb in different experiments showed marked variation. Other important factors must be involved, e.g. the speed with which contents pass through the intestine, the amount of water consumed, the capacity to excrete absorbed Pb etc.

No specific action of vitamin D upon the absorption of Pb could be observed. Upon a high Ca diet the absorption of Pb was low and upon a low Ca diet the absorption of Pb was of the same order as that on a diet which did not contain additional vitamin D.

Large quantities of fat in the diet did not appear to influence the absorption of Pb.

SUMMARY

The effect of variation in the concentration of certain constituents of the diet upon the absorption of Pb from the alimentary tract of mice has been studied.

On high Ca diets, the absorption of Pb was low while upon low Ca diets it was high. Fat and vitamin D were without influence.

I wish to thank Dr A. B. Anderson for his helpful criticism and advice.

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