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Effect of Alginate on the Absorption and Excretion of ²⁰³Pb in Rats fed Milk and Normal Diets

ALGINATE has been shown to be an effective selective inhibitor of strontium absorption from the diet of man and animals¹⁻⁴. Its use as a short term dietary additive to reduce the absorption of ⁹⁰Sr in contaminated environments seems feasible and, because of this, interest has been shown in the effect of alginate on the absorption of other metals.

Hodgkinson *et al.*⁵ have reported a significant reduction in the apparent absorption of Ca, Mg, Zn, Cu and Fe in man and feel that dietary supplements of these elements might be necessary during prolonged alginate therapy. Carr and Harrison *et al.*⁶, however, report no effect on the absorption of Na, Mg, K or P in man and an increased absorption of ⁵⁹Fe, ⁶⁵Zn and P in the rat⁷.

The experiment reported here shows the effect of alginate on the absorption and retention of ²⁰³Pb in the rat. Because the normal rat diet has a high cereal content, a high milk diet was included so that it would more closely resemble that of man, especially the infant.

Four groups of five female albino rats, 7 to 8 weeks old, were placed in metabolism cages and fed 17 g/day of one of the following diets for six days: (a) standard laboratory diet plus 10 per cent cellulose powder; (b) standard laboratory diet plus 10 per cent sodium alginate (Alginate Industries Ltd, Manuocol SS/LD2); (c) commercial low fat milk powder plus 20 per cent cellulose powder and 5 per cent sucrose; (d) commercial low fat milk powder plus 10 per cent sodium alginate, 10 per cent cellulose powder and 5 per cent sucrose.

On the third and fourth days, each animal received approximately 10 μ Ci of carrier-free ²⁰³Pb in 0.001 M nitric acid added to its diet (²⁰³Pb supplied by MRC Cyclotron Unit, Hammersmith). The separate collection of urine and faeces was started with the first dose of isotope and continued until the sixth day. On the sixth day the animals were killed and the gut, carcass, urine and faeces separately digested in nitric acid for the measurement of ²⁰³Pb. The results are shown in Table 1.

In the rat, 10 per cent alginate in the standard laboratory diet increases the absorption of ²⁰³Pb by a factor of about 2.5, but with a milk diet, an approximately equal reduction is obtained. In the groups fed a milk diet, it was difficult to separate urine from faeces so that the figures given for the urine in these groups may be high.

Table 1. THE EFFECT OF ALGINATE ON THE ABSORPTION AND EXCRETION OF ²⁰³Pb IN RATS

Group	Urine	Per cent intake of ²⁰³ Pb Faeces	Carcass	Absorption*
Laboratory diet, 10 per cent cellulose	0.15 (0.014)	96.4 (0.4)	3.5 (0.4)	3.7 (0.4)
Laboratory diet, 10 per cent alginate	0.29 (0.033)	91.0 (0.8)	8.9 (0.9)	9.1 (1.0)
Milk diet, 20 per cent cellulose	6.9 (2.4)	85.7 (1.6)	4.0 (1.0)	10.9 (2.6)
Milk diet, 10 per cent alginate, 10 per cent cellulose	2.15 (0.3)	96.0 (1.7)	1.8 (0.1)	4.0 (0.3)

* Absorption is given as urinary excretion + carcass retention.

All figures are a mean of five animals.

Figures in parentheses are standard errors of the mean.

These preliminary results indicate that the effect of alginate on the absorption of lead is small, and depends on dietary conditions. It does not seem therefore that alginate therapy would be complicated by any major

increase in lead absorption. In the young, who are most at risk⁸, some slight protection might be expected.

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Effect of Alginate on the Absorption of Lead in Man

EXPERIMENTS carried out in this laboratory have shown that adding an alginate derivative rich in guluronic acid to the diet of man, in the proportion of 10 g of alginate to 1 g of dietary calcium, reduces the absorption of strontium, and therefore strontium-90, by a factor of four¹. Indeed, for a milk diet, the corresponding decrease was about six-fold², and, in these conditions, the absorption of calcium was decreased only by a few per cent. Ideally, an alginate supplement should suppress the absorption of strontium without affecting the absorption of essential elements, and it has been shown that there was no reduction in the absorption of Na, K, Ca, Mg, Fe or Zn or in the body retention of P (ref. 3) in rats fed for a year on a commercial diet containing 10 per cent of commercial alginate (Manuocol SS/LD/2, Alginate Industries, Ltd).

The expected stability constants of other metal alginates indicate that such dietary supplements may suppress the absorption of certain heavy metals, many of which are regarded as toxic. In particular, the ionotropic series quoted by Haug⁴ shows that lead is much more strongly bound to alginate than to strontium. If the absorption of lead could be reduced by alginate supplementation, this would be of considerable interest because lead accumulates slowly in body tissues and, although its acute toxicity is relatively low, there is evidence that appreciable body burdens of lead may be acquired by children⁵.

A preliminary investigation of lead absorption in rats showed that when they were fed on a commercial nut diet the absorption of lead was slightly but significantly increased by alginate supplementation, but a slight decrease in absorption was produced in rats fed on a milk diet. These results stimulated the present experiments on man.

Three volunteers from this unit each took 5 μ Ci of ²⁰³Pb ($T_{1/2}$ = 52 h, E_{γ} = 0.28 MeV), in a slightly acid solution of the chloride containing about 25 μ g of lead carrier, near the end of two evening meals, 10 days apart. On the first occasion, 5 g of a purified guluronic rich alginate derivative⁶ was taken in water by each subject about half-way through the meal, and 40 and 68 h later 20 ml. of venous blood was withdrawn. A similar routine was followed after the second dose of ²⁰³Pb, this time without