CARTAS AL EDITOR

Iron absorption from skim milk enriched with iron glycerophosphate *

Gentlemen:

A program aimed at the prevention of protein deficiency in pre-school children has been carried out by the Venezuelan National Institute of Nutrition since 1958 (1). Each child enrolled in this program is administered a daily dose of 60 g of dehydrated skim milk enriched with vitamins and minerals, dissolved in 250 ml of water. This product, referred to as "P.L." contains the following nutrients per 60 g of product:

Protein	16.2 g
Fat	0.5 g
Vitamin A	600 mcg retinol equivalents
Thiamine	0.75 mg
Riboflavin	1.26 mg
Niacin	7.01 mg
Vitamin B_{12}	0.006 mg
Vitamin C	36.0 mg
Vitamin D	150 I. U.
Calcium	1.05 g
Phosphorus	0.74 g
Iron	7.37 mg
D, L-methionine	0.06 g
Food energy	213 kcal

P. L. is supplemented with iron in the form of glycerophosphate, a yellowish salt which, in the amount provided, neither

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changes the color of the powder nor modifies its taste. This iron salt has been used in the treatment of iron deficiency anemia for many years. Since phosphates inhibit iron absorption (2) we were interested in finding out the stability and the iron absorption value of this salt when it is mixed with skim milk. The results of a preliminary study are reported.

Radioisotope analysis of skim milk enriched with tagged iron glycerophosphate showed that this salt remains in solution for several days.

Tagged iron glycerophosphate with a specific activity of 2 μ Ci/ μ g iron was mixed with a given amount of carrier salt and then mixed with iron free P. L. Nineteen children, aged 4 to 7 years, who resided at the nursing-home "Colonia Hogar Concepción Palacios" were studied. A dose of iron-free P.L. enriched with tagged ^{55}Fe-glycerophosphate (7 mg Fe) was administered in the morning after an overnight fast. Next day the children were given P.L., enriched this time with ^{59}Fe-labelled ferrous sulfate. Fifteen days later blood samples were taken and the subjects were then fed a reference dose of iron ascorbate (3 mg Fe) tagged with ^{59}Fe. Blood samples were again taken after 30 days. The hematological characteristics and the radioactivity were determined for each subject. The results of these studies are summarized in Table 1.

Absorption of iron glycerophosphate was slightly higher than that of ferrous sulfate; the mean absorption ratio was 1.23. The hemoglobin values, per cent of transferrin saturation, and absorption of a reference dose of iron ascorbate indicated that iron deficiency and iron deficiency anemia were present in only a few cases. Consequently, better absorption of this enriched milk can be expected in children with marked iron deficiency.

The daily physiological variations in iron absorption need to be taken into consideration when two simultaneous iron absorption tests are compared. In order to obtain more accurate results further experiment was carried out (Table 2) in which equal proportions of iron as glycerophosphate and sulfate tagged with different isotopes were administered with a single dose of P.L. in one meal to eleven adult subjects living in a rural community. The mean iron absorption from glycerophsophate and sulfate was 2.04 and 2.10% respectively. The mean ratio of ferric glycerophosphate to ferrous sulfate absorp-

TABLE Nº 1
IRON ABSORPTION FROM SKIM MILK ENRICHED WITH FERRIC GLYCEROPHOSPHATE

Identification	Age	Sex	Hb.g/100 ml	Serum iron µg/100 ml	Transferrin saturation (%)	Per cent of iron absorption		
						Skim milk enriched with		Iron ascorbate given alone (7 mg Fe) ^{59}Fe
						Iron glycerophosphate (7 mg Fe) ^{55}Fe	Ferrous sulfate (7 mg Fe) ^{59}Fe	
1) L.Q.	6	F	11.4	61	16	0.95	1.25	35.56
2) J.F.	6	F	12.5	64	21	1.06	1.12	22.49
3) M.A.M.	4	M	13.4	111	27	1.99	1.26	27.54
4) D.A.	6	M	11.6	56	16	2.50	2.96	16.14
5) D.J.V.	6	M	12.3	135	32	2.95	0.65	15.12
6) N.J.B.	5	M	12.5	72	18	3.79	3.96	20.23
7) W.J.S.	6	M	12.0	89	25	4.69	2.62	21.68
8) D.Ch.	7	F	12.5	49	11	5.13	4.41	38.52
9) R.J.V.	5	M	12.5	85	27	5.34	4.38	17.31
10) R.C.I.	4	F	11.7	86	22	5.53	3.74	31.98
11) D.P.	6	M	12.8	52	14	5.65	5.17	15.21
12) N.A.F.	4	F	12.5	30	7	6.06	6.94	31.35
13) P.D.P.	5	M	11.7	50	18	6.37	5.87	30.24
14) N.E.P.	6	F	13.0	63	15	8.12	11.56	41.14
15) J.J.S.	5	M	12.7	62	18	8.53	6.53	14.46
16) D.M.F.	5	F	11.9	105	28	10.01	8.27	53.48
17) I.M.M.	4	F	10.7	33	9	13.06	11.21	17.48
18) R.M.F.	4	F	12.5	56	17	13.80	9.87	39.51
19) E.M.Ch.	5	F	12.5	103	23	18.72	10.55	56.49
Mean						5.02	4.08	26.93
Limits 1 S.E.						(4.17 - 6.03)	(3.35 - 4.96)	(24.47-29.64)

TABLE Nº 2
ABSORPTION OF IRON GLYCEROPHOSPHATE AND FERROUS SULFATE ADMINISTERED WITH SKIM MILK IN A MEAL

Identification	Age	Sex	Hb.g/ 100 ml	Serum iron µg/100 ml.	Transferrin saturation (%)	Per cent of iron absorption		
						Skim milk enriched with		Iron ascorbate given alone (7 mg Fe) ^{59}Fe
						Iron glycerophosphate (3.5 mgFe) ^{55}Fe	Ferrous sulfate (3.5 mgFe) ^{59}Fe	
1) L.P.	60	F	12.4	88	35	0.68	0.68	15.34
2) R.R.	62	M	12.8	111	28	0.62	0.73	22.76
3) J.E.A.	45	M	15.3	70	21	0.86	0.79	5.55
4) D.A.R.	23	M	16.3	201	52	1.16	1.26	4.81
5) M.U.	43	F	14.2	57	22	1.80	1.68	6.20
6) L.T.	36	F	13.0	136	36	1.90	1.79	5.25
7) D.S.	40	F	14.7	138	42	1.98	2.12	27.48
8) B.P.	60	F	12.0	63	15	4.90	4.65	22.79
9) J.P.R.	29	M	15.4	97	26	4.15	4.75	68.20
10) M.P.	32	M	14.3	88	25	5.94	6.62	28.02
11) B.L.	22	F	12.0	112	27	7.46	7.61	25.82
Mean						2.04	2.10	13.89
Limits 1 S.E.						1.56 - 2.66	1.60 - 2.75	10.61-18.19

tion was 0.95 with a standard error of only 0.04, indicating that iron utilization is similar when either one of these salts is administered with skim milk.

The subjects tested in the last experiment had better iron stores than those of the former; this is probably the main reason for the low absorption values observed.

If the absorption of ferrous sulfate in Table 2 is corrected to account for the differences found between the mean absorption of iron ascorbate in these two studies, the result is 4.07, which is the same as that found in the first experiment.

Milk ranks among the food products with the lowest iron content -0.1 to 0.3 mg per 100 ml. Its iron absorbability is also low: in six normal adult men the arithmetical mean was 3%, while in children below 5 years of age, whose iron stores were possibly reduced, it was 11% (3). Stekel (4) found 7% of iron absorption in children fed with lowfat milk enriched with 10 mg per liter of iron as ferrous sulfate. The present study shows a lower iron absorption than in Stekel's study, but iron concentration in the Venezuelan milk product is higher and the possibility exists that iron metabolic status of the groups studied was different.

Regarding the iron salt used in our study, Fritz et al (5) have shown in chicks that iron glycerophosphate is absorbed almost as well as ferrous sulfate.

The efficacy of the enriched skim milk (P.L.) in protecting children against protein deficiency was demonstrated by increases in height and weight of children receiving this food supplementation. The efficacy of its iron supplementation was also tested. It was found that in 28 children with marked anemia the mean hemoglobin value increased from 8.1 g % before supplementation started to 9.1 g% by the end of the second month and to 10.7 g% after six months of treatment (1).

These data seem to indicate that nutritional supplementation with P. L. is a good measure to prevent both protein and iron deficiency anemia in children.

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