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The effect of bread fortified with ferrous bisglycinate or reduced iron on the iron status of young schoolchildren.

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**Introduction**

Food fortification is an important strategy for addressing micronutrient deficiencies in developing countries. However, finding the ideal iron fortification compound, i.e. a compound of high bioavailability that will not cause organoleptic problems, remains a challenge. Ferrous sulphate has a high relative bioavailability, but is a reactive compound that can cause organoleptic changes in the fortified product if stored for long periods. Reduced iron (electrolytic) has a bioavailability 50% that of ferrous sulphate, and is the fortificant of choice for food fortification, especially for flour<sup>1</sup>, but can be affected by the inhibitors of iron absorption. The iron in chelated iron compounds, such as ferrous bisglycinate, is protected from the inhibitors of iron absorption, and is also less likely to cause organoleptic problems. Studies have shown that ferrous bisglycinate as fortificant has a bioavailability 2-4 times that of ferrous sulphate<sup>2,3,4</sup>. To date there are no studies comparing the effect of reduced iron with that of ferrous bisglycinate. The aim of this study was to compare the effect of an iron amino acid chelate (ferrous bisglycinate), used as a fortificant in bread, with the effect of electrolytically reduced iron on the iron and haemoglobin status of iron deficient primary school children in a randomised controlled trial.

**Study population and design**

The study population comprised 160 grade 1-3 primary school children (aged 6-11 years) with low iron stores (serum ferritin < 20 µg/L) from a low socio-economic community in the Northern Cape, South Africa ± 400 km from Cape Town. Subjects were randomly assigned to one of three treatment categories: (i) a group receiving standard unfortified brown bread (n=53); (ii) a group receiving fortified brown bread using electrolytically reduced iron [Roche Vitamins South Africa (Pty) Ltd] as iron fortificant (n=53); and (iii) a group receiving fortified brown bread using ferrous bisglycinate [Albion Laboratories, Inc] as iron fortificant (n=54). Bread was distributed under close supervision in colour-coded containers, and compliance monitored and recorded daily. Each child received four slices of bread (120g) per school day over two meal periods. The fortified bread supplied 2.5 mg (25% RDA) elemental iron per day for a period of 4.5 months; and 5 mg (50% RDA) for the remaining 3 months. Bread was provided for a total of 133 school days, providing a total of 490 mg elemental iron over the 7.5-month intervention period. Children were dewormed 3 weeks prior to baseline measurements (500 mg mebendazole)

and again 6 months later.

### **Measurements**

Haemoglobin, serum ferritin, serum iron, transferrin saturation, C-reactive protein and serum retinol were measured before and after 7.5 months of intervention. Serum transferrin receptor was measured only in the children with baseline serum ferritin levels below 15 µg/L. Height and weight was measured and expressed as Z-scores. Qualitative information on food intake before school, after school and during the evening was collected by means of a short questionnaire.

### **Baseline results**

At baseline, stunting, underweight, wasting (Z-scores < -2SD) were present in 27.3%, 28.0% and 5.8% of the children, respectively. Mean haemoglobin was  $12.63 \pm 0.86$  g/dL, with 7.5% being anaemic (Hb <11.5 g/dL). Mean serum retinol was 35.5 µg/dL, with only 1% (one child) with a serum retinol concentration <20 µg/dL. Only 26.8% of the children with serum ferritin <15 µg/L had abnormal serum transferrin receptor values (>8.3 µg/ml), suggesting that despite low ferritin levels the majority of these children did not have functional iron deficiency. Qualitative data on dietary intake revealed that, although bread was the staple food in the diet of these children, animal protein, particularly organ meat (freely available in this community, and a concentrated source of micronutrients) was also fairly often consumed by these children.

### **Results of the intervention**

In the children with baseline serum ferritin <15 µg/L, haemoglobin increased significantly in the ferrous bisglycinate group ( $P = 0.044$ ) compared to the control group; this increase was more than double the increase in the reduced iron group, which showed no significant intervention effect. (Table 1). There was also a significant intervention effect for serum iron (Table 2) and transferrin saturation (Table 3) in the ferrous bisglycinate group ( $P < 0.05$ ), but not in the reduced iron group. The change in serum iron and transferrin saturation in the ferrous bisglycinate group also differed significantly ( $P < 0.05$ ) from that in the reduced iron group. Despite initial low serum ferritin levels there was no significant increase in serum ferritin in either the ferrous bisglycinate or reduced iron groups (Table 4). Results from the children with baseline serum ferritin <20 µg/L showed a similar trend, except that the intervention effects were not statistically significant.

### **Conclusion**

In this non-anaemic iron deficient population ferrous bisglycinate as fortificant in brown bread performed better than electrolytically reduced iron over a period of 7.5 months. How these two iron compounds will perform in relation to each other in an anaemic population is not known and should be investigated. The high serum retinol levels in this population may be due to the high intake of organ meat (e.g. liver) in this community, which is an inexpensive source of animal protein, but a concentrated source of micronutrients. The lack of response in serum ferritin may be due to the high serum

retinol levels, which may have resulted in iron being optimally mobilised from the body stores.

### **References**

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