

Regular Consumption of Micronutrient Fortified Biscuits Improves Anemia and Iron Status of School Children Living in Rural Vietnam

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Introduction

Anemia and micronutrient deficiencies are prevalent in school children living in rural Vietnam. The Fasevie program developed by the NIN, IRD and GRET aimed at defining and implementing nutritional interventions for the most vulnerable groups. Food fortification with micronutrients is considered as a cost-effective intervention. Iron supplementation, especially weekly iron supplementation that can easily set-up in schools, could be an alternative solution.

Fortified biscuits and iron supplements

Biscuits, produced by a private Vietnamese company Haiha, were fortified with micronutrients for this efficacy study, to allow a daily portion of 5 biscuits to meet 50 % of the recommended daily intake of iron, vitamin A, zinc, iodine and 7- 40% for the other vitamins and minerals. Iron tablets were produced by the Pharmaceutical University, Hanoi, Vietnam to allow providing children with 1-2 mg iron/kg body weight.



Production of fortified and non-fortified biscuits and packaging (with color code) under supervision

Objective of the study

To evaluate the efficacy of micronutrient fortified biscuits and weekly iron supplementation on iron, zinc and vitamin A status

Subjects and methods

Setting: Bac-Tra-My and Tien-Phuoc districts, Quang Nam province in center Vietnam.

Subjects: 6-13 year old schoolchildren (1st to 3rd grade, 98 % between 6-9 y. of age) of both sexes

Randomization: children were randomly assigned to 3 groups:

- > **FB group:** children received the fortified biscuits 5 days/week
- > **Control group:** children received the non-fortified biscuits 5 days/week
- > **SUP group:** children received iron supplements (1-2 mg iron / kg b.w.) once per week and non-fortified biscuits 4 days/week.

Treatments were distributed at school during school days under supervision by teachers. The intervention period lasted 6 months.

Children were dewormed after baseline due to a compulsory provincial program.

Methods:

4 ml blood were withdrawn before the intervention (T0) and six months after (T6). Hemoglobin concentration (Hb) was measured with a blood cell counter Celdyn 1700. Plasma was then separated by centrifugation (5000g, 10 mns, 4°C), aliquoted and stored at -70°C until analysis of ferritin (F), transferrin receptors (TfR), zinc (Zn) and retinol (Ret) concentrations.



Anemia was defined by Hb<115 g/L, lack of iron stores by SF<12 µg/L and tissue iron deficiency by TfR>8.5 mg/L. Body iron was calculated according to: body iron (mg/kg) = -[log (TfR/SF) - 2.8229] / 0.1207 (Cook et al, 2003). Iron deficiency (ID) was defined by SF<12 µg/L and/or TfR>8.5 mg/L and iron deficiency anemia (IDA) by simultaneous anemia and ID.

Anthropometry was assessed at T0 and T6 by trained field assistants.

Ethics: The study protocol was approved by the Scientific Committee and the Ethical Committee of the NIN. Only children with informed consent of their parents participated to the study.

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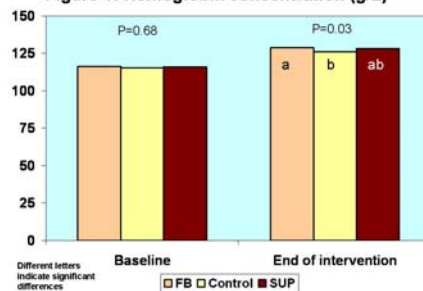
Statistical analysis: Comparison of treatment groups for endpoint values and changes between baseline and endpoint was performed by analysis of variance (ANOVA) for continuous outcomes (Hb, F, TfR, Body iron, Zn, Ret) and by logistic regression for binary responses variables (anemia, ID, low F, Zn and Ret values and elevated TfR values). When data were not normally distributed, statistical analysis was carried out after log transformation (F). When the overall treatment F or LR test was significant, differences among groups were further investigated with conservative multiple comparison tests (Bonferroni's post hoc comparison).

Results

At T0, among the 384 children included in the study, 42.9% had anemia ; 11.7% had iron deficiency ; 24.9% had low plasma retinol (<0.70 µmol/L) and 44.8% low plasma Zn concentrations (<0.65 µg/mL). Stunting was found in 33.8% of children, underweight in 40.2% and wasting in 9.8% of children. No variable was significantly different between groups.

At T6, Hb was significantly higher in FB group (128.8 ± 7.3 g/L) compared to control group (125.8 ± 8.9 g/L) whereas Hb in SUP group (128.0 ± 7.8 g/L) was not different compared to FB and control groups. Between T0 and T6, Hb had increased by 13.3 ± 8.7 g/L in FB group significantly more than in control group 10.2 ± 8.4 g/L. The increase in SUP group of 11.8 ± 8.6 g/L was intermediate (Figure 1).

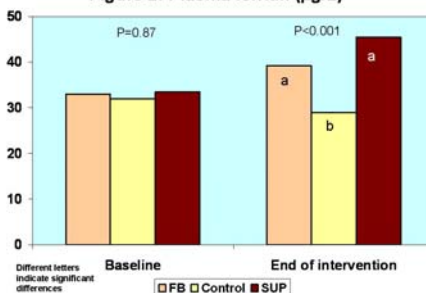
Figure 1: Hemoglobin concentration (g/L)



At T6, F was significantly higher in FB group (39.2 µg/L, CI: 35.1 - 43.8) and SUP group (45.4 µg/L, CI: 40.3 - 51.1) compared to control group (28.8 µg/L, 24.6 - 33.8). Between T0 and T6, F had increased in FB group by 7.8 ± 20.3 µg/l and in SUP group by 11.8 ± 27.9 µg/l whereas it decreased in control group by 2.5 ± 19.5 µg/l (Figure 2).

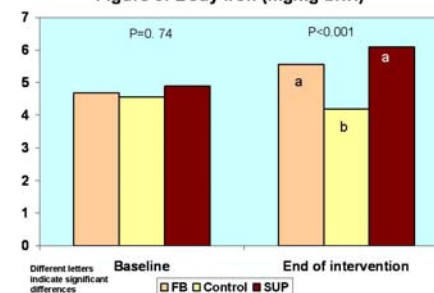
Endpoint TfR was significantly lower in FB group (5.67 ± 1.05 µg/mL) and SUP group (5.66 ± 1.18 µg/mL) compared to group 2 (6.19 ± 1.72 µg/mL).

Figure 2: Plasma ferritin (µg/L)



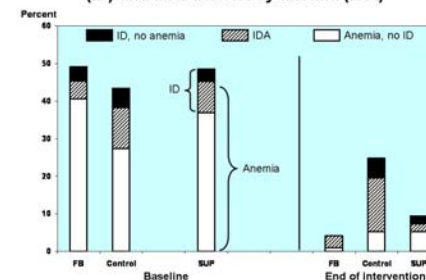
At T6, body iron was significantly higher in FB group (5.56 ± 2.15 mg/kg b.w.) and in SUP group (6.10 ± 2.47 mg/kg b.w.) compared to control group (4.19 ± 3.34 mg/kg b.w.). Between T0 and T6, body iron increased significantly more in FB group (1.11 ± 2.13 mg/kg b.w.) and SUP group (1.31 ± 2.37 mg/kg b.w.) compared to group 2 (-0.26 ± 2.00 mg/kg b.w.) (Figure 3).

Figure 3: Body iron (mg/kg b.w.)



At T6, the prevalence of anemia was significantly lower in FB group 1 (1.0 %) compared to control group (10.4%) and SUP group (7.4%) (p=0.02). Endpoint prevalence of iron deficiency was significantly lower in FB group (3.1%) and SUP group (4.2%) than in control group (19.6%)(p<0.001) (Figure 4).

Figure 4: Prevalence of anemia, iron deficiency (ID) and iron deficiency anemia (IDA)



At T6, mean plasma retinol and zinc concentrations, as well as prevalence of low plasma retinol and low plasma zinc values, were not different between groups. However, in children with low plasma retinol at baseline, retinol changes were significantly higher in FB group 1 (0,16 ± 0,13 µmol/L) compared to control group (0,03 ± 0,12 µmol/L), and intermediate in SUP group (0,09 ± 0,22 µmol/L).

Conclusions

Both regular consumption of biscuits fortified with micronutrients (5 days per week) and weekly iron supplementation improved iron status of school children. However, hemoglobin concentration was significantly higher and prevalence of anemia significantly lower only in the group that received the micronutrient fortified biscuits compared to the control group indicating the benefit of other micronutrients in addition to iron for hemoglobin synthesis.



Special thank to the children who participated to the study