

BIOAVAILABILITY OF IRON FROM *SPIRULINA PLATENSIS*

Maznah Ismail, Yim Hip Seng, Nawalyah Abd.Ghani, Normah Hashim and Hishamudin Omar

Faculty of Medicine and Health Sciences
Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor,
Malaysia

Keywords: iron bioavailability, iron status, spirulina, food supplement, haemoglobin repletion.

Introduction

The prevalence of iron deficiency anaemia remains a major health concern not only in the developing countries but also in the developed world as it affects physical and mental development especially of children. Low bioavailability of iron from the diets has been postulated to contribute to this condition. Mineral deficiency conditions especially when affecting children would be a liability to the growth of the nation in terms of future workforce as well as the overall development of the country especially when the health problem can be rectified by mineral supplementation. At present all multiple mineral supplements are chemically produced. The current opinion is that it is safer to take minerals in the form of food supplements where they occur in their natural form in combination with all of the other nutritive factors such as enzymes and trace elements for optimum assimilation and biological activity. This project has thus focussed on the possible use of *Spirulina platensis* as a mineral food supplement and specifically in this study to determine the bioavailability of iron from *Spirulina* and hence its effect on the iron status *in vivo*.

Materials and Methods

Cultivation of *Spirulina*: *Spirulina* was cultivated at the Centre for Oceanography and Mariculture Studies (COMAS), UPM, Port Dickson. It was harvested by continuous centrifugation and freeze dried to form a concentrate. Its mineral content was determined by AAS. ***In vivo Study:*** Fe bioavailability was assessed *in vivo* by haemoglobin depletion - repletion assay. 30 weanling (28-30d) male Sprague Dawley rats were made iron deficient by feeding Harlan Teklad Fe-deficient diet ($11.67 \pm 3.51 \mu\text{gFe/g}$) for 28d. The rats were then weight-matched and divided into five equal groups according to the supplementation treatment of their diet; commercial *Spirulina* (SC), cultured *Spirulina* (SP), FeSO_4 with 10 fold Fe (FS), continued on Fe-deficient diet (CD) and Barastoc Fe-sufficient diet (CF; $101.27 \pm 4.14 \mu\text{gFe/g}$). The preparation of supplement groups (SC & SP) was based on therapeutic dose of 2 mg Fe/kg body wt. The supplementation was administered every three days in accordance to a report by Viteri et al. (1995). Baseline and interval readings of iron status, haemoglobin (Hb), haematocrit (Ht), mean corpuscular volume (MCV) and serum ferritin were determined by Hematology Analyzer and Imx Ferritin Analyzer respectively. Fecal Fe was determined by AAS.

Results and Discussion

Mineral Composition: The iron content of cultured *Spirulina* ($442.63 \pm 92.35 \mu\text{g/g}$) was found to be higher than commercial *Spirulina* ($126.30 \pm 39.58 \mu\text{g/g}$). ***In vivo Study:*** The growth of the rats was correlated with food intake ($r=0.843$, $p<0.01$), with r values among individual groups ranging from 0.571 for group FS to the highest r value of 0.934 for group CD. The low correlation value obtained for group FS was due to the dehydration caused by undesirable taste of FeSO_4 which eventually resulted in a decrease of food intake and body weight. Since the supplemented dose for iron in group FS was 10 fold greater, therefore, total iron consumption was significantly higher (380-460%) than that of groups SC and SP ($p<0.01$). Meanwhile, SC and SP groups was comparable in their Fe consumption throughout the supplementation phase. At the end of the Fe-deficiency inducing period all the rats were successfully made iron deficient with the mean Hb value being $6.8 \pm 0.59 \text{ g/dl}$. Statistical analysis showed there was no significant difference in pre-supplementation Hb, Ht and MCV values for all experimental groups. Post-supplementation Hb, Ht and MCV for SC, SP, FS and CF groups were significantly higher than pre-supplementation values. Meanwhile, these indices have shown lower post supplementation values for group CD as the rats were continuously fed on Fe-deficient diet. ANOVA for post-supplementation serum ferritin showed no difference between groups SC, SP and FS ($p<0.01$). However, group FS has significantly higher post-supplementation serum ferritin than the two control groups, CD & CF ($p<0.05$). Therefore these results indicate that the regeneration efficiency of Hb synthesis Ht and MCV was comparable between cultured *Spirulina*, commercial *Spirulina* and ferrous sulphate. However, the supplemented dose of Fe for group FS was ten times greater, with the actual amount of iron consumed by the group between 380 and 460% and thus Fe-bioavailability from FeSO_4 was only about one fourth to one fifth at the same serum ferritin level as compared to groups SP and SC.

Conclusions

This study concludes that cultured *Spirulina* may be used in the prevention and treatment of iron deficiency anaemia as it helps in the repletion of haemoglobin in otherwise iron depleted condition. The positive effects could be due to the high bioavailability of iron from this source and they were comparable to that of commercially prepared *Spirulina* and ferrous sulphate supplement which was administered with 10 fold higher dosage. Furthermore the cost per capsule of the commercially prepared *Spirulina* is similar to that of conventional iron supplement but *Spirulina* in addition to iron also contain other nutrients.

References

- Viteri, F.E., Liu, X.N., Tolomei, K., and Martin, A. 1995. True absorption and retention of supplemental iron is administered every three days rather than daily to iron-normal and iron-deficient rats. *The Journal of Nutrition*. 125: 82-91.