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Adsorption of Iron or Ferritin by Chitosan

To the Editor: I have read with interest Burke et al.'s paper entitled "Evaluation of chitosan as a potential medical iron (III) ion adsorbent" in a recent issue of the Journal (30: 341-8, 2000). In vitro adsorptive capacity of 20 mg chitosan (C3) in normal human blood was found to be about 7.5% (iron decreased from 40 µg/dl to 37 µg/dl in 3 hours incubation). The authors also showed that the same amount of chitosan (c3) adsorbed about 10.7% (620 µg/dl from 5795 µg/dl) iron (!) in thalassemic patient blood, without taking into consideration that ferritin (an iron containing substance) is the most likely adsorbed iron, but not the elemental iron for which the experimental design was prepared. Therefore, I believe the adsorption of ferritin iron should not be interpreted solely as iron (III) adsorption.

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To the Editor: Answer to Prof. Şinasi Özsoylu's Letter.

We are thankful to Prof. Özsoylu for his interest in our article and for his valuable criticism. Here we present our opinions against this criticism:

Our study is based on chitosan, which is a very active chelating agent. In our published article it is stated that chitosan is used in various applications, including food, textiles, cosmetics and medicine. It is also stated that it is used as a dietary food (reference 6) and as an adsorbent for urea and ammonia (references 7-9), and it is worth studying chitosan as an oral, parenteral or subcutaneous iron-chelating agent (reference 5). Therefore, the

research is based on the preparation of chitosan samples with various degrees of deacetylation values and the study of the iron adsorptive capacity of these prepared samples.

Our calculation of adsorbed iron was carried out by considering that the amount of ferritin in blood is directly proportional to the amount of iron stored in the body. A decrease in ferritin level is an indication of a decrease in stored iron in the body. That is the reason why we reported a 10.7% decrease in iron when we observed a 10.7% decrease in the ferritin level. The results of five new blood contact experiments give from 6% to 29% decreases in ferritin level depending on the type of chitosan sample used and the composition of the blood sample. It is true that an oversimplification has been made when a decrease in ferritin level has been treated as decrease in iron in calculating the value of 0.55 mmol adsorbed iron / g chitosan. This was done by considering that ferritin might not be the only source of iron bound to chitosan. It is possible to take another approach, as Prof. Özsoylu suggests, and consider that about 25% of ferritin (molecular weight ~ 450 000) is iron. Then this value reduces to 0.14 mmol Fe⁺³ (iron bound to ferritin)/ g chitosan. It is clear that none of these values are ultimate results, but are expected to show variations according to the experimental conditions.

Prof. Özsoylu suggests that it is not elemental iron that is adsorbed onto chitosan, but the ferritin molecule itself. We propose that several possibilities for the iron binding mechanism of chitosan should be considered:

- 1) adsorption of iron complexed to low molecular weight carrier molecules which exist in equilibrium with ferritin which is in equilibrium with haemosiderin [1],

- 2) adsorption of ferritin iron [2],
- 3) adsorption of ferritin itself.

This requires investigation beyond the scope of our published article.

It is clearly stated in our article that the results reported are only preliminary. We are aware that further studies, and a number of more detailed blood analyses (such as serum iron and total iron binding capacity TIBC in addition to ferritin and also haemosiderin) and analysis of chitosan itself after the blood contact must be undertaken in order to obtain more accurate results.

As chemists, our main aim in carrying out this investigation was to study this potential of chitosan as an iron chelator and, by publishing the very early results, to draw the attention of the medical profession to this interesting subject.

We believe that it is worthwhile to investigate chitosan, a polymer of natural origin, as an iron-adsorbing agent. On the other hand, we also stated that toxicity of chitosan in living systems is still under investigation (references 10, 11).

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