Iron Storage

(Effect of dietary iron on the accumulation of iron in the liver of European Starlings)

by S. Crissey, A. Trusk, S. Block and P. McGill
Chicago Zoological Society
Brookfield Zoo, Brookfield, Illinois

Summary

It is extremely important to provide appropriate levels of nutrients in the diets of captive rare and endangered birds. It appears that iron, while essential in the diet, may be potentially harmful to some birds. A study was performed to test the effects of dietary iron on the storage of iron in the livers of a model species, the European Starling. It was found that while the liver iron content increased in all birds over time, a significantly higher level of iron was found in those birds consuming very high quantities of dietary iron. It is recommended that diets of captive birds which may be susceptible to iron storage disease be fed diets which meet the probable minimum iron requirement. However, care should be taken to assure that dietary iron quantities be limited to the lowest level reasonably obtained in a nutritionally complete diet.

Iron is an essential nutrient in the diet of birds. It is needed to maintain good health and normal body metabolism. Too little iron in the diet will cause anemia while too much will cause toxicity problems.

Some captive exotic birds such as toucans, mynas, birds of paradise, and tanagers may store excessive quantities of iron in their livers. This condition is suspected to have contributed to premature death in some of these birds. It is not known whether this iron storage disease is a result of a heritable condition of abnormal iron deposition which occurs regardless of iron level in the diet or is a response to chronic ingestion of excessive iron in the diet.

Iron content of foods varies greatly depending on the soil and climatic conditions under which the food is grown. Thus, the same food type can be high or low depending on farm conditions. Iron can also be inadvertently added to foods during storage, processing and cooking. Manufactured diets such as pelleted foods contain variable levels of iron. It is difficult to control or limit the level of iron in a manufactured feed because iron can be present in almost every ingredient used.

Iron uptake in the body is usually very poor in most animals. Only 5 to 15% of dietary iron is absorbed by humans so there is rarely a toxicity problem. However, it may be possible that some birds, especially fruit eating birds, which may have a difficult time finding good sources of iron in their free-ranging diet, have developed the ability to better absorb iron from their natural diet. Additionally, different sources of iron, from animal, soil, or plant sources, are absorbed differently. Animal sources appear to be absorbed better in most animals.

In captivity, it is nearly impossible to replicate the free-ranging bird's natural diet. To provide for the bird's nutrient requirements, it is appropriate to offer a number of different food sources including manufactured, pelleted diets. It has become apparent that in providing all other nutrients in adequate quantities, we may be oversupplying iron to some susceptible birds. However, until this study we were not sure if, in fact, diet had any relationship to iron storage disease in birds or if the disease progressed regardless of diet.

In order to better characterize the circumstances surrounding iron storage disease and dietary iron intake, we performed a study with European Starlings. We utilized the starling as a model since it is inappropriate to study the potentially unhealthy effects of excessive dietary iron in rare or endangered birds. The purpose of the study conducted at Brookfield Zoo with starlings was to examine whether excess iron storage can be induced by diet and, a) what level of dietary iron will cause iron storage disease and, b) how much time is needed to see the effects of excessive dietary iron.

To test these effects, two groups of fledgling starlings were fed diets containing two different levels of iron. The 46 birds were kept as unrelated pairs in cages. Each of the 23 pairs of birds was fed a diet containing either 148 ppm iron (the low iron diet) or 3,035 ppm iron (the high iron diet). Body weight and diet intake were monitored throughout the study. Measurements of liver iron content and liver weight were taken from half the birds on each diet at ten weeks and the remaining birds at 18 weeks. Histopathological exams which visually assess iron deposition also were performed on the livers at these times.

What we found was extremely interesting. All birds consumed similar quantities of food and maintained relatively constant body weights throughout the study. All appeared healthy upon visual examination. However, there were liver changes occurring. At ten weeks the birds had similar iron levels in their livers, regardless of the diet they were consuming. There also was a tendency for iron to accumulate in their livers of all birds at 18 weeks, regardless of diet. However, the quantity of dietary iron did have a significant affect on liver iron accumulation. At 18 weeks, those consuming the high iron diet had much greater quantities of iron in their livers. Additionally, birds on the high iron diet also had larger livers when compared to those on the low iron diet.

When compared to the potential problem of iron storage disease in rare and endangered birds, this should be considered a preliminary study. However, these results may point out some important factors which pertain to the dietary management of the more rare and endangered birds which may be susceptible to this disease.

Given that we are not sure of the actual requirement for iron in these species, it is recommended at this time that the level of iron in the diet be not lower than 67 ppm, the iron requirement for chickens. It appears prudent to feed "low" iron diets to birds susceptible to iron storage disease such as toucans, mynas, birds of paradise, and tanagers. It should be kept in mind that it is difficult to provide otherwise nutritionally complete diets to birds while maintaining minimum levels of iron in those diets. Thus, at this point, low levels are in practicality just moderate levels of below 200 ppm set as a guideline.

Further studies are essential to determine the affect of intermediate dietary iron levels and the source of dietary iron on iron storage disease. ●