Preventing Cancer with Clay

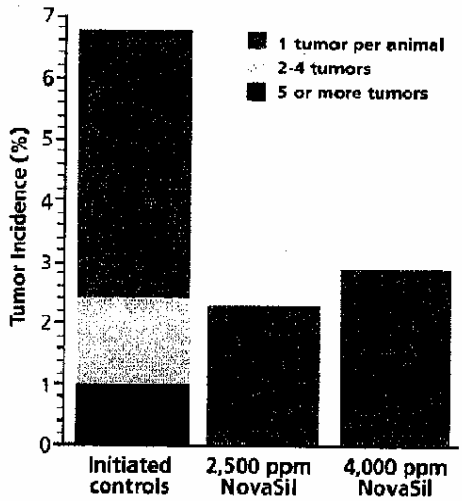
Gayle Orner, Ph.D.
Assistant Professor (Senior Research)

Aflatoxins are naturally occurring toxins formed by molds. Corn and peanuts are often affected, especially when grown in drought conditions or stored at high temperature or humidity. These toxins can produce severe liver damage or cancer in humans. Even with the best agricultural practices, some contamination by aflatoxins, such as aflatoxin B_1 (AFB_1), is unavoidable. In the United States, strict regulations and testing by industry and government agencies have been largely effective at minimizing aflatoxin levels in the nation's food supply, though at a cost of approximately 1.4 billion dollars per year. However, the screening process is not foolproof. Despite the fact that raw materials are screened, every few years an outbreak of fatal aflatoxicosis occurs in dogs, a species far more sensitive than humans to the acute toxic effects of aflatoxins. The same company implicated in the recent peanut butter *Salmonella* outbreak had previously been cited by the FDA for distributing peanut products containing unacceptable levels of aflatoxins on multiple occasions. In many developing countries, the process of screening and discarding contaminated grains is just not economically feasible. Worldwide, over 4.5 billion people are unavoidably exposed to chronic, high levels of aflatoxins, and this exposure is believed to be a major factor in the high rates of liver cancer in some countries. There is an urgent need to develop safe and effective methods to reduce the impact of accidental or unavoidable aflatoxin exposures on human health.

One strategy to minimize dietary aflatoxin exposure is to include substances in the diet that bind to these agents and slow their uptake. LPI investigator Dr. George Bailey and colleagues have demonstrated that the successful cancer chemopreventive agent chlorophyllin (CHL) acts primarily through this mechanism. Another agent that appears to block aflatoxin uptake through a similar mechanism is a type of clay known as NovaSil (NS).

Geophagy, the deliberate consumption of dirt or clay, has been a well-documented phenomenon for centuries. One hypothesis for the consumption of clay by certain tropical birds is that the clay reduces absorption of plant toxins and allows the consumption of plants that would otherwise be toxic. Native American recipes for acorn bread frequently included mixing the meal with clay and water, a practice that reduced the levels of bitter-tasting tannins. In some cultures, geophagy is common among pregnant women who report that the practice reduces the nausea and vomiting that is common in the first trimester. This may be due to the ability of the clay to adsorb toxins, buffer the gastrointestinal tract, or provide supplemental calcium. Other clays might provide protection towards toxins like aflatoxins.

NovaSil is an anti-caking additive commonly added to animal foods. In the late 1980s our collaborator, Dr. Timothy Phillips from Texas A&M University, first reported that this particular clay bound to aflatoxin with high affinity and high specificity. His research team subsequently reported that NS could prevent the acute toxicity induced by aflatoxin in a wide variety of animals, including rats, mice, chickens, turkeys, cattle, lambs, and pigs. In poultry, NS was so effective that it was able to provide almost complete protection against poisoning from aflatoxins even when the AFB_1 levels were hundreds of times above the toxic levels. Recently, Dr. Phillips' laboratory found that supplementation with NS reduced levels of aflatoxin biomarkers in the blood and urine of humans from Ghana who are exposed to high levels of aflatoxin in the diet.



Inhibition of AFB_1- initiated tumor incidence by NS.

Although these studies clearly showed that dietary clay could protect against the acute toxicity of aflatoxins, there was no direct evidence that NS could prevent cancer in any animal model. In 2006, I received an LPI pilot project grant to determine if NS could prevent aflatoxin-induced DNA damage and cancer in rainbow trout. Trout were selected for this project for several reasons. Trout are exquisitely sensitive to aflatoxin-induced liver cancer; indeed, the first evidence that aflatoxin caused cancer was from studies conducted in the 1960s by OSU researchers using rainbow trout. Studies involving hundreds of animals can be conducted in this model at a modest cost. There is a long history of using rainbow trout to study chemopreventive agents, including the seminal work by Dr. George Bailey's laboratory that established CHL as a highly effective chemoprotective agent against aflatoxin-induced liver cancer.

Two separate tumor studies were conducted to determine if NS inhibited AFB_1-induced DNA damage and liver cancer. In the first study, trout were given diets containing AFB_1 at three times the level allowed in U.S. food supplies, plus one of two levels of NS or CHL. In each study, NS significantly reduced the amount of AFB_1 bound to liver DNA. The figure above shows the effect of either 2,500 or 4,000 ppm NS at inhibiting the liver tumor incidence induced by 60 parts per billion (ppb) AFB_1. NovaSil and CHL had comparable effectiveness in inhibiting tumor incidence induced by 160 ppb AFB_1 (not shown).

Our pilot studies confirmed that dietary NS is effective at reducing both DNA damage and liver cancer in AFB_1-treated trout. NovaSil, like CHL, has the potential to reduce the global impact of aflatoxin exposure on human health. Future studies will examine the effectiveness of these two agents when given in combination. LPI