

AFLATOXIN AS A PUBLIC HEALTH FACTOR IN DEVELOPING COUNTRIES

Aflatoxin (AF) is a toxin produced by fungi acting on staple crops (like maize, rice, cassava and peanuts) that constitute a large part of the diet of people living in developing countries. For these people there is little management of food quality and they are at risk of uncontrolled exposure to AF. In the USA, human foods must have less than 20ppb (the threshold for cumulative genetic toxicity) but the threshold for diagnosable symptoms of acute aflatoxicosis (jaundice, vomiting, abdominal pain, hemorrhage, pulmonary edema and death) is much higher. Veterinary toxicology has shown chronic, moderate exposure results in suppressed immunity, nutrition and increased infectious diseases (Williams et al. 2004). These results from animal studies are being found relevant to humans living in developing countries.

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The Importance of Aflatoxin

Only when trade is at stake, or when contamination is so bad that diagnosable deaths by aflatoxicosis are reported have developing nations paid serious attention to this toxin. However, the case for this toxin to be taken seriously lies in the fact that AF can enhance the burden of disease, and mortality rates through immune and nutritional impairment. Since the major effects of AF are indirect, or in the case of cancers deferred until later in life so most nations neglect this aspect of food quality.

An estimated 4.5 billion people living in developing countries are at risk of uncontrolled, or poorly controlled exposure (Williams et al. 2004). Although research has neglected the promotion of diseases by AF this proposition does have a credible basis (discussed later), and as much as 43% of the burden of diseases is modulated by AF (Williams et al. 2004).

What is Contaminated

Studies of contamination in market places find up to 40% of the commodities traded in local African markets exceed the allowable levels of AF contamination defined by *Codex alimentarius* for foods. Maize, peanut, local rice, and many dried foods may be contaminated.

A major area of neglect and opportunity is foods stored by small farmers for their own consumption. A very common consequence of quality control in markets is for farmers to retain, for their own use, grains that would reduce the price offered in the market place. Studies of peanuts in local storage facilities show a steady increase in contamination levels and these differences are observed in the cyclical variation in the biomarkers of rural African people.

Who is Exposed

Biomarkers of exposure show about one in three nursing mothers in West Africa consumed contaminated food during the previous 24 hours. Other African studies with a biomarker for chronic exposure report that almost all people observed had consumed contaminated foods in the last 60 days (Jolly et al. 2006). Children and unborn babies may also be exposed to AF, indeed the early growth of infants is conditioned by placental AF exposure levels (Turner et al. 2007). Our data shows the poor (Jolly et al. 2006) and people with HIV are more exposed than the general population.(Jolly et al. 2009)

The Wide Consequences of Exposure

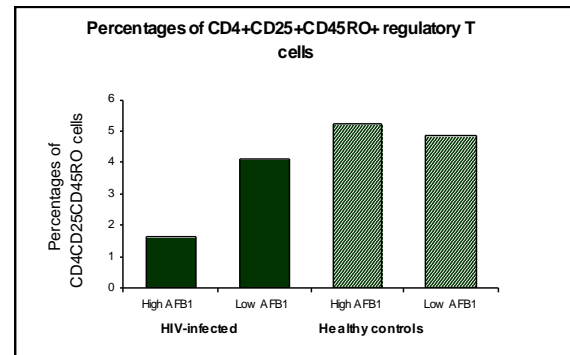
The cancer consequences of AF are much less important than infectious diseases and nutrition. Studies over the past 10 years suggest that reduced nutrition and lowered immunity by this toxin probably exacerbates the top seven health risks in developing countries; ***AF does not cause HIV, TB, malaria and other infectious diseases it just makes them more common, more severe and more lethal.***

Immunity and infectious diseases

HIV

The premise that HIV and AF may be synergistic was first proposed in 1989 (Hendrickse et al. 1989), but this suggestion was not followed up for 15 years. In Ghana we have found through a cross sectional study that the immune systems of HIV infected people are significantly modified if they have above median levels of natural exposure to AF (Jiang et al. 2008). In addition to confirming that immunity is impaired by high AF, we found that the combination of HIV and AF exposure resulted in:

- Decreased percentage of B lymphocyte cells (indicative of a decrease in antibody response).
- Decreased perforin expressing CD8 cells (indicative of decreased cytotoxic activity).
- Decreased regulatory T cells (suggesting increased immune hyperactivation and increased immunopathology) (see figure). These changes indicate that AF may accelerate progression to AIDS.



AF also modulates micro-nutrients critical to survival with HIV. Thus it is possible that by addressing the AF we may provide also nutritional benefits for HIV sufferers. Existing knowledge allows us to suggest that the rate at which HIV progresses may be subject to AF exposure, and that intervening in this exposure will delay the course of HIV/AIDS.

Malaria

The available data show that malaria may be promoted by any agent that suppresses immunity; people with a high AF biomarker status in The Gambia (Turner et al. 2003) and Ghana (Jolly et al. 2007) were more likely to have active malaria.

Tuberculosis

Very little study has happened in this area, but the importance of AF to cellular immune function and the established connection between HIV and TB suggest that TB will be promoted by exposure to AF. The first results (unpublished) from a Peanut CRSP study in Ghana support this proposition. Over a two year period HIV patients with high AF status were much more likely to develop clinical TB than those with lower exposure.

Nutritional status

In animals, contaminated feed is well recognized as a reason for the young to not thrive and to grow slowly. Aflatoxin in the diets of animals has been proven to interfere with protein nutrition and multiple micronutrients (vitamins A, C, D, E; and Zinc, Selenium and Iron). This same phenomenon is observed in humans: exposure to AFs in African children is associated with stunting and with the condition of underweight (Gong et al. 2004), while vitamins C (Turner et al. 2003), A and E (Tang et al. 2009) status are now also associated with exposure. Although no data exists to show that AF promotes zinc deficiency in humans, there is good animal data that shows maternal AF exposure impacts the zinc status of nursing young and that this results in greater susceptibility to diarrheal diseases (Mocchegiani et al. 2001).

Increased risk of iron anemia during pregnancy has recently been associated with high AF status.

NOTE DR. WILLIAMS HAS KINDLY OFFERED TO PROVIDE ADDITIONAL INFORMATION/QUESTIONS ADDRESSED TO HIS EMAIL ADDRESS: : twillia@griffin.uga.edu

Citations:

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