Risk Assessment of Total Aflatoxin (AFT) and Aflatoxin B1 (AFB1) through Consumption of Corn and Peanuts by Adult Filipinos

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INTRODUCTION

Aflatoxin contamination in agricultural crops has been one of the serious threat in health and causes economic loss in tropical Southeast Asian countries including the Philippines (Leong et al., 2011). Staple foods such as corn and peanuts are the two most common agricultural crops susceptible to infestation of molds (Fig.1) at both pre- and post-harvest that results to aflatoxin production by three species of Aspergillus namely A. flavus, A. parasiticus and A. nomius. Long term exposure of consumers to small amounts of aflatoxins especially the aflatoxin B1 (AFB1) type, which is considered as a human carcinogen, can lead to the development of hepatocellular carcinoma (HCC) or liver cancer (WHO, 2010).

Moreover, hepatitis B virus (HBV) infected individuals are more prone to aflatoxin-induced liver cancer due to damaged liver. With these concerns in food safety, the Philippine National Standard/ Bureau of Agriculture and Fisheries Product Standards (PNS/BAFPS) harmonized with Codex and US standards has set the Maximum Tolerable Limit (MTL) for aflatoxins at 20 µg/kg for Filipino consumers’ health protection.

This study estimated the exposure and health risk of the general population of adult Filipinos within 18 to 65 years old, with or without HBV infection, to aflatoxin-induced liver cancer or HCC from the consumption of aflatoxin-contaminated corn and peanuts.

MATERIALS AND METHODS

Collection of Secondary Data

Hazard Identification & Characterization

Exposure Assessment

Risk Characterization

- Published Local and International Journals (1999-2004) on AFT and AFB1 studies in the Philippines
- Incidence of aflatoxin contamination, Hepatitis B infection & Liver Cancer
- Computation of Estimated Daily Intake (EDI) using the 2013 NNS Consumption data of Adult General Population with 57.7kg body weight (kgBW)
- Estimation of Cancer Potency among Hepatitis B virus (HBV) infected/carrier and non-infected adult Filipinos
- Computation of Margin of Exposure using the EFSA benchmark dose level (BMDL)

Figure 1. Aflatoxin contaminated Corn & Peanuts

Figure 2. Flow chart of the Methodology
Limited data on aflatoxins in the Philippines especially for raw peanuts were gathered (Table 1). Publications by Arim et al. in 1999 and Arim R.H. were used to compute for the total aflatoxin and aflatoxin B1 concentration of raw and unprocessed corn. Meanwhile, only the study of Palomar, M.K. was used for raw peanuts.

Table 1. Published Data of Aflatoxin Studies in the Philippines

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Source</th>
<th>Year</th>
<th>Number of Samples (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>Arim et al.</td>
<td>1997</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1998</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Arim, R.H.</td>
<td>2003</td>
<td>42</td>
</tr>
<tr>
<td>Peanuts</td>
<td>Palomar, M.K.</td>
<td>1998</td>
<td>100</td>
</tr>
</tbody>
</table>

The average aflatoxin levels for both commodities have exceeded the PNS/BAFPS standard maximum tolerable limit (MTL) at 20 µg kg⁻¹ that signified adequate pre- and post-harvest measures or practices to manage aflatoxin contamination particularly in peanuts were not observed (Table 2).

Table 2. Average Aflatoxin Concentration in Corn and Peanuts

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Aflatoxin Levels (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFT</td>
<td>AFB1</td>
</tr>
<tr>
<td>Corn</td>
<td>39.97</td>
</tr>
<tr>
<td>Peanuts</td>
<td>353.71</td>
</tr>
</tbody>
</table>

Based on the 2013 National Nutrition Survey (NNS), the consumption of corn by adult Filipinos is 12.15 g/person/day and 0.31 g/person/day in peanuts. The average Estimated Daily Intake (EDI) of AFB1 from the consumption of aflatoxin contaminated corn is higher than in peanuts (Fig.3). Even with lower level of aflatoxin contamination in corn, adult Filipino corn consumers have higher exposure to AFB1 that can develop to HCC or liver cancer.

Figure 3. Average EDI of AFB1 in Corn & Peanuts

(ng/kgBW/day)

Corn: 6.52
Peanuts: 1.44

High prevalence of chronic hepatitis B (CHB) in the Philippines was reported at 16.7% of the population, equivalent to 7.3 million CHB adults. Results showed that adult Filipinos infected with or as carriers of Hepatitis B are the most susceptible population to develop liver cancer through chronic exposure to aflatoxin contaminated corn and peanuts (Fig. 4).

Figure 4. Estimated Annual Cases of Liver Cancer Induced by Aflatoxin Exposure per 100,000 Adult Filipinos

The highest estimated annual liver cancer cases that can develop from aflatoxin exposure were evident among adult Filipino corn consumers with CHB at an average of 2.52 (AFT) and 1.96 (AFB1) annual HCC incidence/100,000 persons than in peanuts at 0.43 (Fig.4).

The total potency of AFT (0.109) and AFB1 (0.084) to cause liver cancer among adult Filipinos is higher from exposure to aflatoxin contaminated corn than in peanuts (0.02-0.03).

Moreover, the lower estimated margin of exposure (MoE) to AFB1 in corn (26.23) than in peanuts (118.0) indicates higher exposure of adult Filipinos to DNA-damaging and cancer-causing AFB1 from consumption of AFB1 contaminated corn (Fig. 5). Estimated MoE values < 10,000 indicated a potential concern for human health and a potential 10% increase in liver cancer incidence (WHO,FAO).

CONCLUSION & RECOMMENDATION

Adult Filipinos with high consumption of aflatoxin-contaminated corn and peanuts as staple foods are highly exposed to develop liver cancer especially those with chronic hepatitis B infection. The low MoE estimates showed the high potential health risk for chronic aflatoxicosis or aflatoxin poisoning among adult Filipinos on long term exposure to low levels of aflatoxin in corn and peanuts. Additional studies using tiered-approach (Probabilistic and Total Diet Studies) are recommended to further estimate the exposure to aflatoxins from corn and peanut by-products of Filipino population. It is also recommended that more stringent agricultural production practices, regulations, and monitoring should be implemented.

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