DIETARY EXPOSURE ASSESSMENT FOR AFLATOXIN B₁ FROM PROCESSED PEANUT PRODUCTS IN MUNICIPALITY OF BOGOR

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ABSTRACT

A research on dietary exposure assessment for aflatoxin B₁ (AFB₁) from processed peanut products in Municipality of Bogor was carried out. The objectives of this study were to determine the contents of AFB₁ in processed peanut products at retail levels, and to obtain information whether there is a risk to public health caused by the consumption of processed peanut products contaminated by AFB₁. Survey of processed peanut product consumption was carried out by interviewing each respondent using a questionnaire of weekly processed peanut product consumption. Sampling of processed peanut products was conducted at the locations where the respondents obtained processed peanut products. The number of roasted peanuts with skin pods, flour-coated peanuts and pecel gado-gado sauces samples was 33, respectively, while the number of sioonay and satay sauces samples was 18 and 12, respectively. The total number of processed peanut product samples was 129. AFB₁ content was determined using Thin Layer Chromatography method. Estimation of the dietary exposure assessment was determined using the actual survey data consisting of AFB₁ content, consumption data and body weight. The highest contaminated sample percentage and mean of AFB₁ content was found in roasted peanuts with skin pods i.e. 42% of 33 samples and 43.2 μg/kg, respectively, followed by flour-coated peanuts (30% of 33 samples and 34.3 μg/kg), and pecel gado-gado (21% of 33 samples and 17.1 μg/kg). Mean of estimated dietary exposure for AFB₁ found in children was 15.2 ng kg⁻¹ bw day⁻¹ and 95th percentile exposure was 38.9 ng kg⁻¹ bw day⁻¹, while in adults 9.0 ng kg⁻¹ bw day⁻¹ and 95th percentile exposure was 27.0 ng kg⁻¹ bw day⁻¹. The excess cancer risk of AFB₁ exposure in Bogor from this study on children and adults was calculated as 193 and 115 cancers/year, respectively.

Key words: dietary exposure assessment, aflatoxin B₁, processed peanut products

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INTRODUCTION

Peanuts are next to rice, maize and soybean as the most important secondary crop in Indonesia. Since Indonesia has a humid tropical climate, peanuts can easily be infected by fungi during the drying phase in the field, or under poor storage conditions. According to Sauer et al. (1992) fungal infection can cause a decrease in physical quality of kernels and nutritional content, rancidity, discoloration, and production of mycotoxin, among others aflatoxin. The toxin has been recognized as human and domestic animals carcinogen, and is produced following the infection of peanuts among others by certain strains of *Aspergillus flavus*. In general, aflatoxins found in foodstuffs and their processed products are aflatoxins B₁, B₂, G₁, and G₂. The most dangerous aflatoxin is B₁ (AFB₁).

The adverse health effects of aflatoxins can be categorized as either acute or chronic. Acute aflatoxicosis occurs when moderate to high levels of the toxins are consumed and may result in hemorrhage, acute liver damage, rapid progressive jaundice, edema of the limbs, alteration in digestion, absorption and/or metabolism of nutrients, high fever, vomiting, swollen livers and possibly death (Fung & Clark 2004).

Hepatocellular Carcinoma (HCC), or liver cancer, is the third leading cause of cancer deaths worldwide, with roughly 550,000-600,000 new HCC cases globally each year (WHO 2008). It has been known for several decades that aflatoxin causes liver cancer in humans, however, the exact burden of aflatoxin-related HCC worldwide was unknown. Liu and Wu (2010) conducted a quantitative cancer risk assessment i.e. using global data on food-borne aflatoxin levels, consumption of aflatoxin-contaminated foods, and hepatitis B virus (HBV) prevalence. Aflatoxins have been classified as Group 1 human carcinogen by the International Agency for Research on Cancer (IARC) and demonstrated carcinogenic effects on many animal species, including some rodents, non human primates, and fish (International Programme on Chemical Safety 1998). Groopman et al. (2008) reported that specific P450 enzyme in the liver metabolize aflatoxin into a reactive oxygen species (aflatoxin-8,9-epoxide), which may then bind to proteins causing acute toxicity (aflatoxicoses) or to DNA causing lesions that over time increase the risk of hepatocellular carcinoma (HCC) or liver cancer. For cancer risk assessment, it is traditionally assumed that there is no threshold of exposure to a carcinogen below which there is no observable adverse effect. National Research Council (2008) stated that cancer potency factors are estimated from the slope of the dose response relationship, which is assumed to be linear, between doses of the carcinogen and cancer incidence in a population. According to IPSC/WHO (1998), aflatoxin risk assessment selected two different cancer potency factors for aflatoxin: 0.01 cases/100,000/year/nanogram/kilogram body weight per day aflatoxin exposure for individuals without chronic HBV infection, and 0.30 corresponding cases for individuals with chronic HBV infection. Kirk et al. (2005) and Ok et al. (2007) reported that several epidemiological studies confirm that aflatoxin's cancer potency is about 30 times greater among HBV-positive than among HBV-negative individuals.
Acute outbreaks of aflatoxicosis have been reported from Kenya (Ngindu et al. 1982, CDC 2004), India (Krishnamachari et al. 1975) and Malaysia (Chao et al. 1991, Lye et al. 1995). Chronic aflatoxicosis results from ingestion of low to moderate levels of aflatoxins and the effects are impaired food conversion (Shane 1993), slower rates of growth (Gong et al. 2002, 2004), and a decrease in various micronutrient levels (Pimpukdee et al. 2004).

Many countries have determined maximum tolerable levels of aflatoxins in peanuts and their processed products. Maximum tolerable levels of aflatoxins B₁, B₂, G₁, and G₂ in peanuts and their processed products in Australia, Canada, Philippines and Singapore were 15, 15, 20, and 5 μg/kg, respectively (FAO 2004). Based on SNI (2009) in Indonesia, the maximum tolerable limit of AFB₁ and total aflatoxins in peanuts and their processed products were 15 and 20 μg/kg, respectively.

Researches on infection and aflatoxin contamination in raw peanut kernels collected from farmers, collectors, wholesalers, retailers at traditional markets have been conducted by Dharmaputra et al. (2005, 2007a). The results indicated that in general the highest aflatoxin contamination of raw peanut kernels was at retailers in traditional markets. Dharmaputra et al. (2007b) reported that the high AFB₁ contents in raw kernels were due to among others by damaged kernels (discoloured, cracked and broken kernels). Lilieanny et al. (2005) stated that the highest aflatoxin content was found in bumbu pecel compared to in roasted peanuts with skin pods, roasted peanuts without skin pods, flour-coated peanuts, bumbu pecel, and enting-enting gepuk.

Data on aflatoxin level in processed peanut products and their consumptions are needed to prepare the dietary exposure assessment for aflatoxin. Most ASEAN countries (including Indonesia) have some data on aflatoxin content in foods, however, no formal risk assessment on aflatoxin has been conducted for the region. This may be due to the lack of technical and financial resources to develop the necessary data and information needed to support or to conduct risk assessment. More data on aflatoxin contents in processed peanut products are needed. In addition, a survey of individual processed peanut product consumption should be conducted to determine aflatoxin exposure assessment (Sparringa 2008).

Dietary assessment is a part of risk assessment, i.e. the process of estimating potential exposure of a population to food chemicals (among others aflatoxin) from the diet and comparing the potential exposure against a reference health standard for risk characterisation purpose. Aflatoxin exposure assessment could be used to estimate the potential exposure/intake of the toxin, to assess the potential risk of health for a population group, and to maintain safe food supply.

The objectives of this study were to determine the contents of AFB₁ in processed peanut products at retail levels, and to obtain information whether there is a risk to public health caused by the consumption of processed peanut products contaminated by AFB₁.
MATERIALS AND METHOD

Pre-survey

Pre-survey consisted of:

a. Determination of data consumption survey location of processed peanut products:

The location of data consumption survey was carried out at Kecamatan (subdistrict) Bogor Tengah covering 11 kelurahan (lowest local government), i.e. Kecamatan Babakan, Babakan pasar, Cibogor, Ciwaringin, Gudang, Kebon kelapa, Pabaton, Palelang, Panaragan, Sempur, and Tegallega. Kecamatan Bogor Tengah has the highest population density (13,445 inhabitants/km²) and was selected to conduct the survey and sampling. In addition, the government center including business activities are also found in this Kecamatan (BPS Kota Bogor 2008).

b. Determination of respondents:

The data of Kecamatan Bogor Tengah office showed that the population at Kecamatan Bogor Tengah until March 2009 was 116,686 people. The number of respondents was determined based on the square root of population at Kecamatan Bogor Tengah, i.e., 342 respondents. In each kelurahan, the number of respondents was determined proportionally based on the number of inhabitants. The respondents were grouped into two categories, i.e., children (6-15 years old, 169 respondents) and adults (16-44 years old, 173 respondents). It was assumed that most children of 6 years and older like to eat processed peanut products, while the adults are more sensitive to hepatic.

Survey of processed peanut product consumption

Survey of processed peanut product consumption was carried out by interviewing each respondent using a questionnaire of weekly processed peanut product consumption concerning:

- the kinds of processed peanut products (bumbu pecel or gado-gado, bumbu karedok, bumbu siomay, bumbu batagor, bumbu satai, bumbu ketoprak, oncom bitam, kacang garing or kacang kutil, kacang atom, kacang telur, and kacang bawang) consumed by each respondent during the last one week
- the frequency of processed peanut products to be consumed by each respondent during the last week
- portion or product number consumed by each respondent during the last week
- the location where each respondent bought the processed peanut products
- the body weight of each respondent

In addition to interviewing each respondent, observation was also conducted to obtain information about the number of processed peanut product sellers found in the surrounding of respondent domiciles. The information was used at the stage of sampling. During survey in each kelurahan, the research team was accompanied by one or two staff of the kelurahan who are familiar with the sites.
Sampling method of processed peanut products

Sampling of processed peanut products was conducted at the locations where the respondents obtained processed peanut products, i.e. from warung pecel or gado-gado, siomay and satay vendors, and small shops.

The number of samples of each processed peanut product was determined based on the number of processed peanut product sellers found in the surroundings of the respondent domiciles. The number of roasted peanuts with skin pods, flour-coated peanuts and pecel or gado-gado sauces samples were 33, respectively, while the number of siomay dan satay sauces samples were 18 and 12, respectively. The total number of processed peanut products samples was 129.

Each sample consisted of 5 portions of processed peanut products in the form of sauce (pecel or gado-gado, siomay, and satay sauces) and 2 kg (= 100 small packs, weight @ 20 g) of other processed peanut products (roasted peanuts with skin pods and flour-coated peanuts). At the time of purchase, the main materials of pecel or gado-gado, siomay and satay were packed separately from their peanut sauces. One portion of gado-gado, siomay and satay contained 75, 50 and 60 g peanut sauces, respectively. Each sample was mixed manually and homogeneously, and then divided into two parts to obtain working samples for AFB1 content determination and a reserve sample. AFB1 content was only determined in peanut sauces.

Determination of aflatoxin B content

AFB1 content was determined using Thin Layer Chromatography (TLC) method (AOAC 2005). Two replicates were used from each sample. AFB1 was extracted from ground processed peanut products using methanol-H2O. The filtrate was diluted using NaCl solution and defatted using hexane. AFB1 was partitioned into chloroform, then it was removed through evaporation, and quantitated using TLC on silicagel plate by visual estimation, i.e. by comparing the spot of standard and sample.

Estimation of the Dietary Exposure Assessment for AFB1

Exposure assessment involves estimating the intensity, frequency, and duration of human exposures to a toxic agent. Dietary exposure to aflatoxin B, in Kecamatan Bogor Tengah was estimated using the AFB1 concentration data, food consumption data and mean body weight. AFB1 exposure was calculated on the group of average consuming (mean) and high consuming (95% percentile). Consumption data were obtained from Food Frequency Questionnaire. The estimation of dietary exposure assessment for AFB1 was determined based on the following formula (WHO 2008):

\[
\text{Dietary exposure} = \frac{\text{Food consumption} \times \text{AFB1 concentration}}{\text{Body weight}} \times 1,000
\]
Pattern of Processed Peanut Product Consumption

Based on five big ranks of consumers, roasted peanuts with skin pods (63% of the total respondent number) ranks first among 11 kinds of consumed processed peanut products in Kecamatan Bogor Tengah, followed by flour-coated peanuts (54.5% of the respondents), siomay sauce (54% of the respondents), peel or gado-gado sauce (49% of respondent number) and satay sauce (34% of the respondents) (Table 1).

In general, either child or adult respondents, bought roasted peanuts, flour-coated peanuts, peel or gado-gado, and siomay from warung, warung peel or gado-gado and vendors. In general child respondents bought satay from vendors, while adult respondents bought it from warung satay. The mean highest number of processed peanut product consumption of child and adult respondents was 0.0110 kg/day and 0.0149 kg/day, respectively, for peel or gado-gado (Table 2). The mean consumption number was obtained from the mean consumption frequency in one day multiplied by the mean consumption portion.

Aflatoxin B1 Content

AFB1 contents were determined in five most consumed processed peanut products i.e. roasted peanuts, flour-coated peanuts, peel or gado-gado sauce, siomay and satay sauces.

The highest contaminated sample percentage and mean of AFB1 content was found in roasted peanuts with skin pods (42% of 33 samples and 43.2 μg/kg), followed by flour-coated peanuts (30% of 33 samples and 34.3 μg/kg), and peel or gado-gado (21% of 33 samples and 17.1 μg/kg). (Table 3).

Table 1. Number of respondents who consumed processed peanut products in Kecamatan (subdistrict) of Bogor Tengah

<table>
<thead>
<tr>
<th>Rank of the products consumed from 1st up to 5th</th>
<th>4</th>
<th>3</th>
<th>5</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note:</td>
<td>1 = Pecel/gado-gado</td>
<td>7 = Karedok Kacang kulit</td>
<td>2 = Karedok</td>
<td>8 = Kacang hitam</td>
<td>3 = Siomay</td>
</tr>
</tbody>
</table>
Table 2. Frequency, portion and consumption number of processed peanut products in Kecamatan Bogor Tengah

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Kind of product</th>
<th>Place of purchase*</th>
<th>Mean of consumption frequency per day</th>
<th>Mean of portion (kg)</th>
<th>Mean of consumption number (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>Roasted peanuts with skin pods</td>
<td>Warung (small shop)</td>
<td>0.40</td>
<td>0.0204</td>
<td>0.0082</td>
</tr>
<tr>
<td></td>
<td>Flour-coated peanuts</td>
<td>Warung</td>
<td>0.31</td>
<td>0.0096</td>
<td>0.0030</td>
</tr>
<tr>
<td></td>
<td>Pecel/gado-gado sauce</td>
<td>Warung</td>
<td>0.24</td>
<td>0.0460</td>
<td>0.0110</td>
</tr>
<tr>
<td></td>
<td>Siomay sauce</td>
<td>Vendor</td>
<td>0.31</td>
<td>0.0164</td>
<td>0.0051</td>
</tr>
<tr>
<td></td>
<td>Satei sauce</td>
<td>Warung satei</td>
<td>0.28</td>
<td>0.0224</td>
<td>0.0063</td>
</tr>
<tr>
<td>Adults</td>
<td>Roasted peanuts with skin pods</td>
<td>Warung</td>
<td>0.34</td>
<td>0.0290</td>
<td>0.0099</td>
</tr>
<tr>
<td></td>
<td>Flour-coated peanuts</td>
<td>Warung</td>
<td>0.32</td>
<td>0.0090</td>
<td>0.0029</td>
</tr>
<tr>
<td></td>
<td>Pecel/gado-gado sauce</td>
<td>Warung</td>
<td>0.26</td>
<td>0.0572</td>
<td>0.0149</td>
</tr>
<tr>
<td></td>
<td>Siomay sauce</td>
<td>Vendor</td>
<td>0.30</td>
<td>0.0263</td>
<td>0.0079</td>
</tr>
<tr>
<td></td>
<td>Satei sauce</td>
<td>Warung satei</td>
<td>0.21</td>
<td>0.0305</td>
<td>0.0064</td>
</tr>
</tbody>
</table>

* Small part of the respondents bought processed peanut products in traditional- and supermarkets or they prepared the products by themselves.

Table 3. Aflatoxin B content of processed peanut products at Kecamatan Bogor Tengah and maximum tolerable limit (MTL) of AFB1 based on SNI (2009)

<table>
<thead>
<tr>
<th>Kind of processed peanut products</th>
<th>No. of samples</th>
<th>Number (%) of samples contaminated by AFB1</th>
<th>Number (%) of samples contaminated by AFB1 &gt; 15 (\mu g/kg)</th>
<th>Range and mean of AFB1 content (\mu g/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roasted peanuts with skin pods</td>
<td>33</td>
<td>14 (42%)</td>
<td>14 (42%)</td>
<td>0 – 316.80 (43.21)</td>
</tr>
<tr>
<td>Flour-coated peanuts</td>
<td>33</td>
<td>10 (30%)</td>
<td>10 (30%)</td>
<td>0 – 160.00 (34.28)</td>
</tr>
<tr>
<td>Pecel/gado-gado sauce</td>
<td>33</td>
<td>9 (27%)</td>
<td>7 (21%)</td>
<td>0 – 197.80 (17.11)</td>
</tr>
<tr>
<td>Siomay sauce</td>
<td>18</td>
<td>2 (11%)</td>
<td>2 (11%)</td>
<td>0 – 39.90 (4.41)</td>
</tr>
<tr>
<td>Satei sauce</td>
<td>12</td>
<td>2 (17%)</td>
<td>2 (17%)</td>
<td>0 – 198.58 (23.17)</td>
</tr>
<tr>
<td>MTL (SNI 2009)</td>
<td></td>
<td></td>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>

The best way to control the presence of aflatoxins in foods and feeds is through good agricultural and manufacturing practices which could prevent fungal growth. Aflatoxins are thermostable compounds and, once formed, they can persist in animal feeds and food. The usual methods of processing peanuts to make peanut butter and processing nuts for confectionery may appreciably reduce aflatoxin contamination. Effective means of reducing aflatoxin contamination include removing undersized nuts, removing nuts that resist splitting and blanching, and removing discoloured nuts by hands or electric sorting (Cole 1989).

Percentage of samples contaminated by AFB1 and AFB1 content of pecel or gado-gado sauce was relatively high. It was probably due to the low quality of peanuts used to prepare the sauces or containers used to store peanut kernels and to prepare the sauces were not clean.

Percentage of samples contaminated by AFB1 and the mean of AFB1 content in siomay sauce were relatively low (11% of 18 samples and 4.4 \(\mu g/kg\)). The percentage of sate sauce samples contaminated by AFB1 was also relatively low, i.e. 17% of 12
samples, but the mean of their AFB1 contents was relatively high, i.e. 23.2 μg/kg (Table 3).

In Indonesia the maximum tolerable limit (MTL) of AFB1 for peanuts and their processed products is 15 μg/kg (SNI 2009). Percentage of roasted peanuts with skin pods, flour-coated peanuts, pecel or gado-gado sauce, siomay sauce and satay sauce samples contaminated by AFB1 exceeded 15 μg/kg i.e. 42% of 33 samples, 30% of 33 samples, 21% of 33 samples, 11% of 18 samples, and 17% of 12 samples, respectively (Table 3). Based on the mean of AFB1 content, among the five processed peanut products, siomay sauce has a mean AFB1 content lower than the MTL (4.41 g/kg). Two out of 18 samples were contaminated by AFB1 exceeding 15 g/kg. The other four processed peanut products contained mean of AFB1 contents higher than MTL. Consequently, risk management of the four products is suggested to be applied.

Lilieanny et al. (2005) stated that total aflatoxin contents of roasted peanuts with skin pods (47 samples), flour-coated peanuts (22 samples), bumbu pecel (12 samples) and eating-eating gepak (4 samples) collected from several factories, supermarkets, and traditional markets in Bogor, Malang, Pati and Yogyakarta from January up to August 2002, were 1.8, 5.2, 41.6 and 20.8 μg/kg, respectively. Aflatoxin was not detected in roasted peanuts without skin pods (3 samples).

**Estimation of the Dietary Exposure for Aflatoxin B**

Mean of estimated dietary exposure for AFB1 in children was 15.2 ng kg⁻¹ bw day⁻¹ and 95th percentile exposure was 38.9 ng kg⁻¹ bw day⁻¹, while in adults 9.0 ng kg⁻¹ bw day⁻¹ and 95th percentile exposure 27.0 ng kg⁻¹ bw day⁻¹ (Table 4). The major contributing foods for AFB1 in children and adults was roasted peanuts with skin pods, followed by pecel/gado-gado sauce, satay sauce, flour-coated peanuts and siomay sauce, while the highest contaminated level was roasted peanuts with skin pods, followed by flour-coated peanuts, satay sauce, gado-gado sauce and siomay sauce. The estimated highest exposures to AFB1 by consuming roasted peanuts with skin pods were 44.5% (adult respondents) and 43% (child respondents) of total exposure to AFB1 (Table 4). Further researches on the risk management of roasted peanuts with skin pods are needed.

The mean dietary intake of aflatoxin for Australian and Swedes were 0.15 and 0.8 ng kg⁻¹ bw day⁻¹, respectively (Thuvander et al. 2001), for Americans 0.26 ng kg⁻¹ bw day⁻¹ (JECFA 1998), for French adults (＞15 years old) was 0.1 ng kg⁻¹ bw day⁻¹, while for children (ages 3-14) was 0.3 ng kg⁻¹ bw day⁻¹. It was assumed, that Bogor community consumed processed peanut products containing higher content of AFB1 compared to other countries. However, Li et al. (2001) reported that in Guangxi, China, the probably daily intake of processed peanut products was estimated 3,680 ng kg⁻¹ bw day⁻¹.

From the five processed peanut products, the lowest dietary exposure for AFB1 was siomay sauce, either on children or adult respondents. Dietary exposure for AFB1 of the five products on children respondents was higher than that of adult respondents (Table 4). This was due to the body weight of children which was lower than that of adults. The lower the body weight of the consumer, the higher the dietary exposure of AFB1.
Dietary Exposure Assessment for Aflatoxin B, from Processed Peanut Products - Santi Ambarwati et al.

Table 4. Dietary exposure assessment for aflatoxin B, from processed peanut products at Kecamatan Bogor Tengah

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Kind of product</th>
<th>Mean of consumption number (kg/day)</th>
<th>Mean of AFB1 content (µg/kg)</th>
<th>Mean of body weight (kg)</th>
<th>Dietary exposure for AFB1 (ng/kg body weight/day)</th>
<th>Percentage of total daily intake</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children</strong></td>
<td>Roasted peanuts with skin pods</td>
<td>0.0082</td>
<td>43.21</td>
<td>33</td>
<td>10.6</td>
<td>43.0</td>
</tr>
<tr>
<td></td>
<td>Flour-coated peanuts</td>
<td>0.0030</td>
<td>34.28</td>
<td>32</td>
<td>3.4</td>
<td>13.7</td>
</tr>
<tr>
<td></td>
<td>Pecel/gado-gado sauce</td>
<td>0.0110</td>
<td>17.11</td>
<td>32</td>
<td>5.6</td>
<td>22.8</td>
</tr>
<tr>
<td></td>
<td>Siomay sauce</td>
<td>0.0051</td>
<td>4.41</td>
<td>32</td>
<td>0.7</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>Satai sauce</td>
<td>0.0063</td>
<td>23.17</td>
<td>31</td>
<td>4.4</td>
<td>17.7</td>
</tr>
<tr>
<td><strong>Adults</strong></td>
<td>Roasted peanuts with skin pods</td>
<td>0.0099</td>
<td>43.21</td>
<td>56</td>
<td>7.4</td>
<td>44.5</td>
</tr>
<tr>
<td></td>
<td>Flour-coated peanuts</td>
<td>0.0029</td>
<td>34.28</td>
<td>57</td>
<td>1.8</td>
<td>10.7</td>
</tr>
<tr>
<td></td>
<td>Pecel/gado-gado sauce</td>
<td>0.0149</td>
<td>17.11</td>
<td>56</td>
<td>4.4</td>
<td>26.5</td>
</tr>
<tr>
<td></td>
<td>Siomay sauce</td>
<td>0.0079</td>
<td>4.41</td>
<td>56</td>
<td>0.6</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>Satai sauce</td>
<td>0.0064</td>
<td>23.17</td>
<td>57</td>
<td>2.5</td>
<td>15.0</td>
</tr>
</tbody>
</table>

**Risk Assessment**

To evaluate the potential health risk of Bogor community to AFB1, a risk assessment of AFB1 should be conducted by comparing the estimation of dietary intake and Provisional Maximum Tolerable Daily Intakes (PMTDI). As AFB1 is a genotoxic carcinogen, the safety factors used for non-genotoxic carcinogens cannot be applied. Therefore, most agencies, including JECFA and US FDA, have not determined yet a tolerable daily intake for AFB1.

JECFA proposed the potency value of 0.3 cancer cases per year per 100000 population per ng aflatoxin per kg body weight for hepatitis B positive individuals, while the potency value for the non-hepatitis B population was 0.01 cancer cases per year per 100000 population per ng aflatoxin per kg body weight (JECFA 1997). Based on the potency value of 0.3 and 0.01 cancers per year per 100000 population per ng aflatoxin per kg body weight, prevalence of hepatitis B in Bogor was 1.4% (Departemen Kesehatan Republik Indonesia 2008), while the population of Bogor end 2007 was 905132 (BPS Kota Bogor 2008). Consequently, the results of this study showed that the cancer risk of AFB1 exposure in Bogor on children and adults was 193 and 115 cancer cases/year, respectively. Therefore, cancer risk could increase due to the consumption of highly AFB1 contaminated processed peanut products.

AFB1 is an unavoidable food contaminant. To evaluate the potential health risk of AFB1 caused by food consumption, it is important to determine the natural occurrence of AFB1 in food and to estimate the risk for liver cancer through dietary exposure to AFB1. Ok *et al.* (2007) reported that the level of AFB1 contamination in 28 of the 32 food products in South Korea was less than 10 kg⁻¹, which is the legal tolerance limit in Korea. From data on daily food consumption, the exposure dose of AFB1 was estimated to be $6.42 \times 10^{-7} \text{mg kg}^{-1} \text{body weight day}^{-1}$. The risk of liver cancer
for those exposed to AFB1 through food intake was estimated to be $5.78 \times 10^6$ for hepatitis B-negative individuals and $1.48 \times 10^5$ for hepatitis B-positive individuals.

**CONCLUSIONS**

The highest contaminated sample percentage and mean of AFB1 content was found in roasted peanuts with skin pods (42% of 33 samples and 43.2 μg/kg), followed by flour-coated peanuts (30% of 33 samples and 34.3 μg/kg), and pecel or gado-gado (21% of 33 samples and 17.1 μg/kg). The percentage of saté sauce samples contaminated by AFB1 was also relatively low, i.e. 17% of 12 samples, but the mean of their AFB1 contents was relatively high, i.e. 23.2 μg/kg. Among the five processed peanut products, sioi moy sauce has a mean AFB1 content lower than the MTL (4.41 g/kg). The other four processed peanut products contained AFB1 higher than MTL. Consequently, risk management of the four products is suggested to be applied. In addition, aflatoxin contamination can be minimized by using good practices, from farm up to table.

Mean of estimated dietary exposure for AFB1 on children was 15.2 ng kg⁻¹ bw day⁻¹ and 95th percentile exposure was 38.9 ng kg⁻¹ bw day⁻¹, while on adults 9.0 ng kg⁻¹ bw day⁻¹ and 95th percentile exposure was 27.0 ng kg⁻¹ bw day⁻¹. The cancer risk of AFB1 exposure in Bogor from this study on children and adults showed 193 and 115 cancer cases/year, respectively. Therefore, cancer risk could increase due to the consumption of highly AFB1 contaminated processed peanut products.

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