INTRODUCTION:
Cancer incidence is rising in Africa with approximately 853,000 people developing cancer annually and an 85% mortality rate as a result of unavailing treatment. Hepatocellular carcinoma (HCC) is one of the most common malignancies in Ghanaian men and women with mortality among Ghanaian patients accounting for 22.2% and 10.8% of all cancer-related deaths respectively. Multiple factors play a role in the etiology of HCC, with chronic exposure to low levels of aflatoxin (AFB) from the diet (e.g., contaminated maize, groundnuts, and other cereal grains). It is well established that the predominant cancer aetiology AFB (AFB1) is one of the most potent naturally-occurring hepatocarcinogens in humans. The humid, yet drought-prone, environment of Ghana promotes growth of the Aspergillus fungi responsible for the production of AFB while food insecurity and maize storage practices (top right) in the Ejura district of Ghana make these populations at high risk for exposure.

Enteral/parenteral intervention strategies using montmorillonite clay (USPN) in animals and humans have proven effective in reducing biomarkers of exposure as well as symptoms of toxicity. USPN inclusion as a food additive in areas with high incidence of aflatoxin exposure would be a sustainable approach to alleviating many public health issues associated with aflatoxins. Favorability of foods containing USPN and efficacy of USPN to bind AFB in foods was assessed both in vitro and in a well-established human population in the Ejura District of Ghana (bottom right).

MATERIALS AND METHODS:

Figure 1. Montmorillonite Clay Structure: A12Si4O10(OH)2

Schematic representation of 2:1 layer-lattice montmorillonite clay showing hydrated cation as the predominant interlayer cation with AFB, based. A net negative charge is responsible for high cation exchange capacity in soils. Common substitutions: Mg2+ for Al3+, Fe3+ for Si4+, and Ca2+ for Al3+. Key: SiO4 (yellow), silica tetrahedron and Al3+ (blue), aluminum octahedron, O3 (red), H2O (white), C (light blue), and Ca2+ (green).

Figure 2. AFB1 Extraction from Maize

Preliminary in vitro study to analyze binding capability of USPN throughout a traditional Ghanaian cooking process. Maize meal (50g) was spiked in triplicate with AFB1, at levels ranging from 50-200ppm with and without inclusion of 1.5g USPN. Samples were run with and without fermentation. Extraction of AFB1 from maize slurry was conducted according to VICAM methods.

Figure 3. Intervention Trial Design (Crossover)

50 participants (baseline)

Baseline urine collection, recruitment, and consent

Group 1 (25)
3.0g USPN/d x 5 d

Group 2 (25)
3.0g Placebo/d x 5 d

Daily urine collection; Palatability questionnaire

2 day washout; Treatment crossover

Group 1 (25)
3.0g USPN/d x 5 d

Group 2 (25)
3.0g Placebo/d x 5 d

Daily urine collection; Palatability questionnaire

CONCLUSIONS:
- The production of organic acids, alcohol, and CO2 during fermentation does not affect binding of AFB1 to USPN.
- USPN sequestered 88%-100% of AFB1 in fermented maize samples at AFB1 levels varying from 50-200ppm.
- In a short-term study, participants consuming up to 3g of USPN per day did not report having any adverse health events.
- Addition of USPN clay in foods does not alter the aroma, taste, or texture.
- USPN significantly (p<0.01) reduced AFB1, urinary biomarkers when compared to placebo controlled groups.

Urinary AFB1 biomarkers can be used to assess efficacy during short-term intervention trials in human populations.

Food inclusion of USPN would be more sustainable and increase the use of the material within Ghana.