

Sir Halley Stewart Trust

Final Report

Project Title: Reducing Toxic Contamination of Staple Foods in Developing Countries by Simple Intervention Programmes

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Summary

The project examined the use of a simple intervention method for reducing consumption of mycotoxin contaminated maize. The project was divided into two parts, Phase I and Phase II. In Phase I, laboratory work determined the most effective method of sorting and washing maize to reduce fumonisin levels with minimal loss of food. In Phase II, the fieldwork, the methods of sorting and washing were taught to a group of volunteer local women in South Africa. Fumonisin levels were measured in samples of cooked and uncooked maize before and after intervention and fumonisin biomarker levels were measured in urine of women who

consumed the maize before and after the intervention. The analysis of collected samples for fumonisin (FB) levels was completed recently in Leeds for the urinary FB1 and in the MRC lab of South Africa for the food FB, respectively. The results show that the intervention produced a significant reduction in fumonisin levels in food and in fumonisin exposure of the women.

Majority of the funding was effectively spent on the two-phased field work and the laboratory analysis of the samples. Besides, the funding supported Dr Gong's trip to take part in the field work and other exchange visits between the two institutes. It also partially (on top of the contribution from the ICRETT fellowship funding) supported Ms L van der Westhuizen's training in Leeds as a key activity of knowledge transfer. The significant output from the funding will certainly enable scientists and policy makers to improve people's food safety and health effectively in the developing world.

Introduction

Fumonisin and aflatoxins are carcinogenic mycotoxins produced by mouldy fungi in maize. Only a proportion of the maize kernels are contaminated by the fungus, so removal of contaminated maize prior to food preparation would reduce human exposure to the toxins (photo 1a and 1b). The aim of the project, therefore, was to evaluate the effectiveness of hand sorting for reducing the mycotoxin levels in maize and in human urine, implemented through the education of local women in South Africa. We anticipated that this study would provide a simple, cheap and effective community level intervention to reduce dietary toxins and associated health risks in developing countries.

Methods

In 2007, the removal of visibly infected maize kernels by hand sorting, and subsequent reduction of fumonisin levels by various washing techniques were optimised (Phase I). Subsequently, the hand sorting and 10 minute washing intervention procedures were implemented in the 2008 field study (Phase II). 22 participants in two areas of the Centane District of the Eastern Cape Province were recruited for the study. Following informed consent, a portion of home grown maize was collected for FB analysis and to be used for the intervention programme. A portion of cooked maize food and a following morning void urine sample was collected on two consecutive days from each participant (figure 1).

The participants were trained in the simple fumonisin reduction procedures (hand sorting and washing), which were then applied to the previously collected maize by each participant (photo 2). A portion of the sorted and washed maize was collected from each participant for subsequent analysis of fumonisin levels. Food parties were held on two consecutive days, at which the women consumed the cleaned maize (photo 3). Morning void urines were collected the morning after each food party. The maize kernels, unsorted and sorted, and the cooked maize porridge samples were analysed for fumonisins using solid phase extraction clean-up followed by fluorescence High Performance Liquid Chromatography (HPLC) method. The urine samples were analysed for fumonisin B1 using solid phase extraction clean-up followed by HPLC- Mass spectrometry analysis. The maize kernels were analysed for aflatoxins using an immunoaffinity column extraction and the fluorescence HPLC analytical method

Results and Findings

In Phase I, the laboratory optimisation, hand sorting of maize kernels reduced the mean total fumonisin contamination by 66%. As the discarded kernels comprised only 2.5% by weight of the total maize the loss of food during sorting was deemed an acceptable sacrifice. A 10

minute water wash of the remaining maize kernels reduced the remaining fumonisin contamination by a further 25%, giving a mean total reduction of 74% (see figure 2).

In phase II, we examined the effect of the intervention (handsorting + washing) on fumonisin levels in (i) uncooked food (ii) cooked food and (iii) urine. Significant reductions in fumonisin levels were observed at all three stages (figure 3). (i) Hand sorting and washing of maize reduced the food level of fumonisin from 1709 $\mu\text{g}/\text{kg}$ (baseline) to 285 $\mu\text{g}/\text{kg}$ maize, an amazing 83% reduction in contamination. (ii) In the cooked maize food the mean fumonisin level was 1269 $\mu\text{g}/\text{kg}$ in baseline cooked maize food samples, which was reduced to 533 $\mu\text{g}/\text{kg}$ in the cooked maize food after intervention, a 58% reduction of the fumonisin contamination. (iii) For the human exposure biomarker, the urinary FB1 mean level was reduced by 52% from 224 pg/ml to 107 pg/ml , as a result of the intervention. The urinary FB1 level was well correlated with the cooked food fumonisin.

No aflatoxins were detected in the maize samples collected from this region.

Output

1. The results are a very positive outcome for this study and the reduction of 83% of the total fumonisin contamination in maize by hand sorting and washing were reflected in the 58% reduction in cooked food and 48% in human urine biomarker.
2. The intervention method was low cost, easy-to-follow and welcomed by the community. It strongly indicates the efficacy of the intervention to reduce individual exposure to this carcinogen.
3. We anticipate publishing two to three peer reviewed papers out of this study. The results will be presented in various mycotoxin and public health conferences.
4. Agreed by the Trust, we obtained a small fellowship funding to support a researcher from the MRC lab to visit Leeds and to conduct the urinary FB1 analysis. The training was

successful and the researcher is now able to conduct the analysis in the MRC laboratory in South Africa.

5. We have secured further funding to provide a larger community educational programme to promote such interventions and prevent the mycotoxin related health risk in the poor communities.

Figures and photos

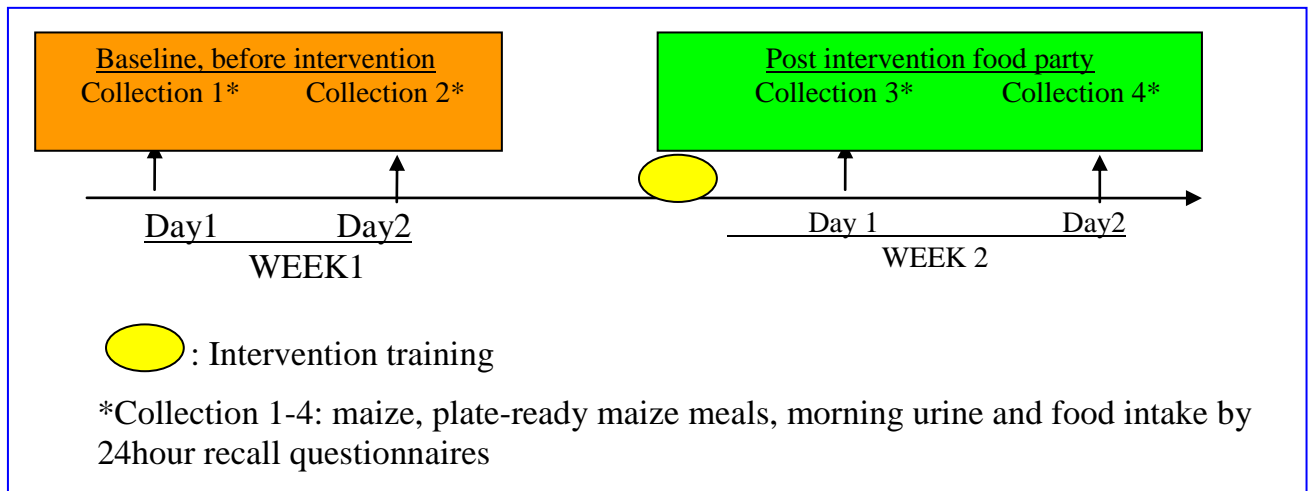


Figure 1: Schema of phase II field work

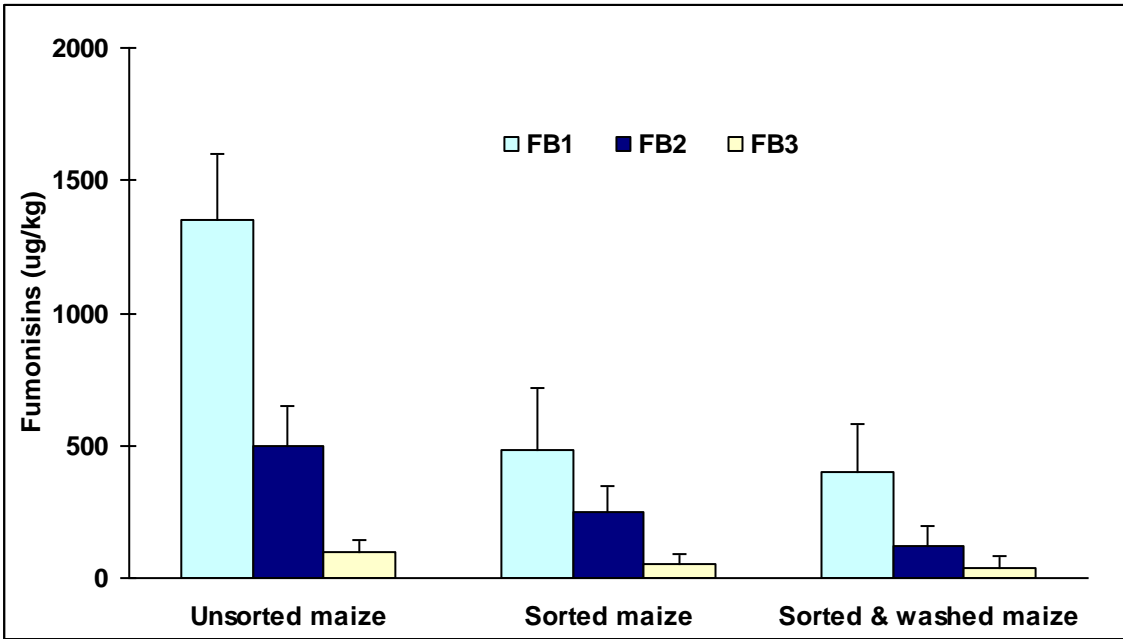


Figure 2: Fumonisin reduction by hand sorting and washing in phase I

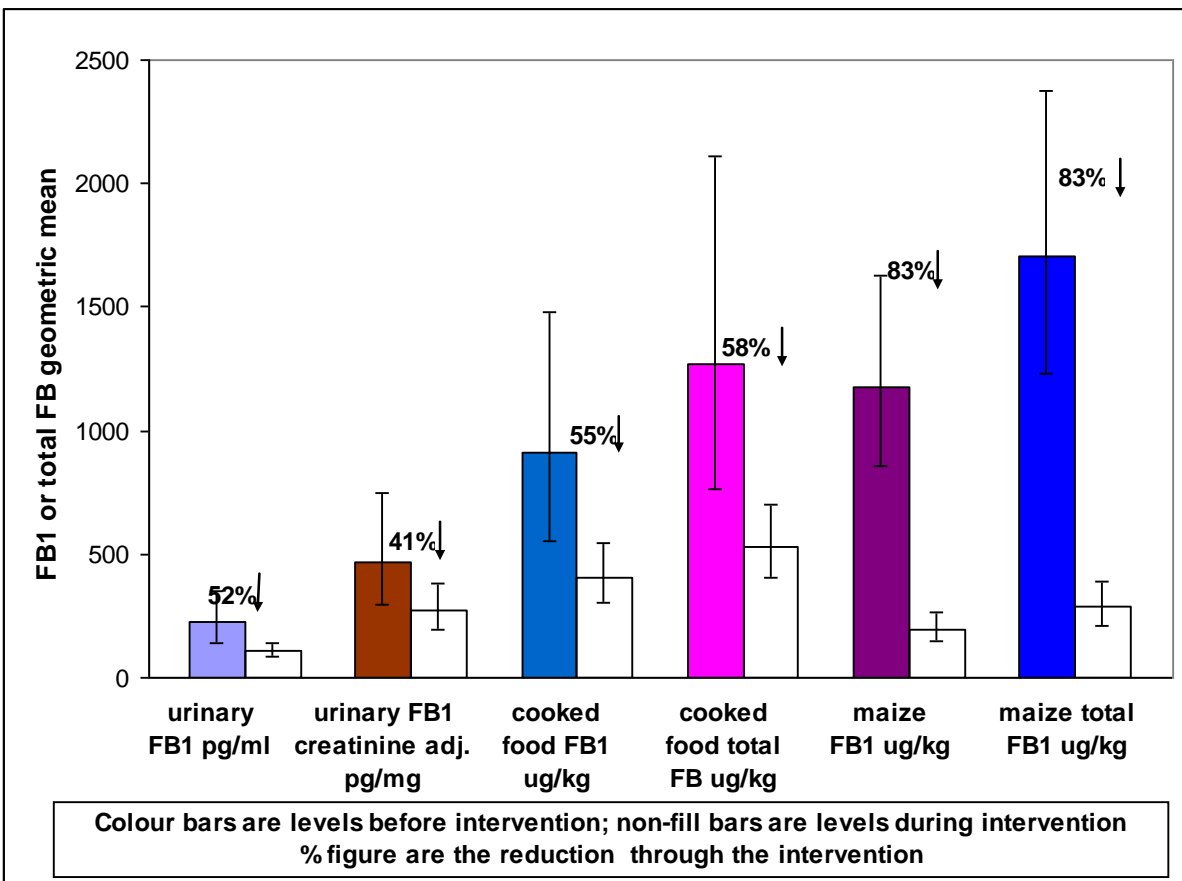


Figure 3: The fumonisin levels (FB1 and/or total FB) in the urine, the cooked food and the maize kernels at the baseline and the intervention phase



Photo 1A Good maize kernels



Photo 1B Contaminated maize kernels



Photo 2: Hand-sorting and washing



Photo 3: The food party

Manuscript in preparation

Van der Westhuizen L, Shephard GS, Rheeder JP, Burger H-M, Gelderblom WCA, Wild CP, Gong YY. Reducing Fumonisin Contamination of Maize Staple Foods by Simple Intervention Procedures in a Rural Area of South Africa.

Van der Westhuizen L, Shephard GS, Rheeder JP, Burger H-M, Gelderblom WCA, Wild CP, Gong YY. Reduction of Fumonisin Contamination in Home Grown Maize from the former Transkei Area of South Africa by Implementing Simple Intervention Procedures.

Van der Westhuizen L, Shephard GS, Rheeder JP, Burger H-M, Gelderblom WCA, Wild CP, Gong YY. Confirming Reduction of Fumonisin Exposure with the Fumonisin B₁ Biomarker in Urine from the former Transkei Area of South Africa.

Seminar

Van der Westhuizen L, Gong YY, Shephard GS, Rheeder JP, Burger H-M, Gelderblom WCA, Wild CP. Reducing Toxic Contamination of Staple Foods in Developing Countries by Simple Intervention Programmes. Presentation at the Molecular Epidemiology Unit, Leeds Institute of Genetics, Health and Therapeutics, Faculty of Medicine and Health, University of Leeds, UK, 13 October 2008.

Plenary address

Mycotoxins and disease: the importance to health in Africa. Chris Wild, Pan African Environmental Mutagen Society, South Africa, Nov 2008

Foodborne toxins and health in developing countries: Chris Wild, American Association for Research on Cancer, Prevention meeting, Washington, Nov 2008

Conferences

Gong YY, Van der Westhuizen L, Rheeder JP, Burger H-M, Gelderblom WCA, Wild CP, Shephard GS. Application of urinary fumonisin B1 as a fumonisin exposure biomarker in an intervention project. ISM 2009, Tulln Austria (oral)

Burger H-M, Lombard MJ, Shephard GS, Van der Westhuizen L, Gelderblom WCA. The use of a validated dietary assessment tool in a human mycotoxin exposure study. Nutrition Congress 2008, University of Pretoria, Hatfield Campus, Pretoria, 28 September – 2 October 2008 (Poster).

Burger, H-M. Nutrition and Cancer An overview. Master Class on Diet Health and Development: What is the Evidence? 22nd Biannual Congress of the Nutrition Society and the 10th Biannual Congress of the Association of Dietetics in South Africa. 28 Sept-02 October 2008. University of Pretoria (Oral).

Burger H-M, Lombard MJ, Shephard GS, Van der Westhuizen L, Gelderblom WCA. The importance of using validated dietary assessment tools in human exposure studies: a case for mycotoxin exposure in the former Transkei region, South Africa. MRC Research Day, MRC Conference Centre, Cape Town, 16-17 October 2008.

Van der Westhuizen L, Gong YY, Shephard GS, Rheeder JP, Burger H-M, Gelderblom WCA, Wild CP. Reducing Fumonisin Contamination of Maize Staple Foods by Simple Intervention Procedures in a Rural Area of South Africa. Chromatography - Mass Spectrometry 2008, Bela Bela, North West Province, 12-15 October 2008. (Poster)

Van der Westhuizen L, Gong YY, Shephard GS, Rheeder JP, Burger H-M, Gelderblom WCA, Wild CP. Reducing Fumonisin Contamination of Maize Staple Foods by Simple Intervention Procedures in a Rural Area of South Africa. PAEMS 2008, Cape Town International Convention Centre, 3-5 November 2008 (Poster).

Van der Westhuizen L, Gong YY, Shephard GS, Rheeder JP, Burger H-M, Gelderblom WCA, Wild CP. Reducing Fumonisin Contamination of Maize Staple Foods by Simple Intervention Procedures in a Rural Area of South Africa. World Mycotoxin Forum –The fifth Conference, Noordwijk, the Netherlands, 17-18 November 2008. (Poster)