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Quality of maize for sale in markets in Benin and Niger

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ABSTRACT

A follow-up study on the quality of maize for sale in West African public markets was carried out in Benin and Niger from August 15–28, 2013. Complementing the earlier study, this present assessment included not only retailers but also wholesalers and maize producers. Samples were evaluated for parameters related to the physical quality of the maize and for aflatoxin contamination. Most maize value chain actors process their offered grain using traditional methods for threshing, winnowing and drying. Maize for sale in the markets surveyed had an average moisture content ranging between 12 and 14%. Non-grain impurities amounted to 0–2.3% while mouldy grains ranged between 0.2 and 0.8%. The impurity level in grain was three times higher among wholesalers compared to retailers and producers. An insect pest, the Larger Grain Borer (*Prostephanus truncatus* (Horn) was found only in Benin but *Sitophilus zeamais* Motschulsky, *Cryptolestes ferrugineus* Stephens, and *Tribolium castaneum* Herbst, were present in maize for sale in the markets in of both countries. Insect pest frequency was 16 times higher in wholesalers' grain compared to that of retailers and producers. Aflatoxin levels exceeding the accepted standard of 20 ppb were noted in markets in both countries. The highest proportion of aflatoxin-contaminated maize was in wholesalers' grain in Malanville market.

1. Introduction

In Africa, maize is a primary food crop for human consumption. In the Sahelian zone, it is consumed in the form of pasta, porridge, pancakes, couscous or grilled (Rouanet, 1984). In Benin, maize production was estimated to be 1.1 million tons in 2012/2013 (Gain Report, 2013), Niger produces comparatively little maize, with annual production estimated at around 7610 tons in 2012/2013 (M.A, 2012). There is need to intensify maize production in Niger, especially in the regions of Agadez, Diffa and Tillabery, which have the lowest yields. Given its maize supply deficit, Niger imports about 45,000 tonnes from Benin, Nigeria, Togo, Ghana, and Burkina Faso (INS-Niger, 2011). Despite its importance, maize faces many problems from production to storage. These are mainly related to the traditional harvesting, drying and storage processes that favour the presence of impurities in the grain and that also expose it to insect pests. In parts of Africa *Prostephanus truncatus* (Horn), the Large Grain Borer (LGB), is a major pest of maize. Losses can reach between 15 and 35% after six to eight months of storage (Chittenden, 1895; Back and Cotton, 1922; Haubruge and Gaspar, 1990; Golob and Hodges, 1982).

Other important insect pests of stored maize include *Sitophilus zeamais* Motschulsky, *Rhizopertha dominica* F., *Tribolium castaneum* Herbst, *Tribolium confusum* Jacquelin du Val (Ortega, 1987; Jacobs and Calvin, 2001; Throne, 1994; Markham et al., 1994).

Aflatoxin contamination is also a major constraint to the utilization and value of maize. *Aspergillus flavus* is one of the most common fungi that produces aflatoxin B1, recognized as a potential carcinogen by the International Agency for Research on Cancer (IARC (International Agency for Research on Cancer) , 1993). The main factors that influence the development of fungi in cereals are moisture content and storage temperature (Mitchell et al., 2004). In the tropics, the temperature is almost always favorable to the development of fungi, making moisture content the main controllable variable affecting the invasion and the growth of fungi (Northolt et al., 1976). Aflatoxin B1 is a threat to human health and food security but also an economic concern to maize traders. Most developed countries have regulations fixing the allowable levels in food for humans and livestock. In the USA the accepted level for

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human consumption is 20 ppb (Wood, 1992) and for the European Union, the maximum acceptable total aflatoxin (B1, B2, G1 and G2) in nuts, dried fruits, cereals and spices is 4–15 ppb (http://www.foodsafetywatch.org/factsheets/aflatoxins/).

These standards hurt the economies of developing countries, especially those that depend on the export of agricultural products to Europe. According to Miller (1996), 40% of maize produced in developing countries contains some level of aflatoxin. In a recent study only 4.6% of maize samples from four West African countries had levels above 20 ppb (Baoua et al., 2016). In Benin, maize produced for human consumption is estimated to be 30% of total crop production (Allogni et al., 2010).

There is little up-to-date information in relation to the quality of maize sold in West African rural markets. This study provides information on post-harvest practices and phytosanitary quality of corn in some rural markets of Benin and Niger and complements our earlier study (Baoua et al., 2016). In this study we worked with traders, growers and market retailers of maize, while the previous study focused on retailers.

2. Materials and methods

We conducted our study in five grain markets in Benin and Niger from August 15–28, 2013 (Fig. 1). The annual temperature ranged from 25 °C to 40 °C and the relative humidity between 30% and 90% in the study countries. We focused on wholesalers and retailers in urban markets and producers located near the major urban centers. The Benin markets included: (1) Bohicon, the largest city in the southern forest area of Benin, located 200 km north of Cotonou; (2) N'Dali, located 50 km north of Parakou in the maize-producing zone, and (3) Malanville, which has an international grain market located at the border with Niger and Nigeria. In Niger the study focused on wholesalers and retailers and was carried out in the urban markets of Dosso, located 170 km north of Malanville, and of Maradi, 550 km east of Dosso. Nigerien producers were not involved in the study because they mostly sell only fresh maize to be grilled or boiled in urban centers.

Respondents were selected randomly. Interviews were carried out at the interviewees' places of work and began with an explanation to them of the reasons for the study. The questionnaire

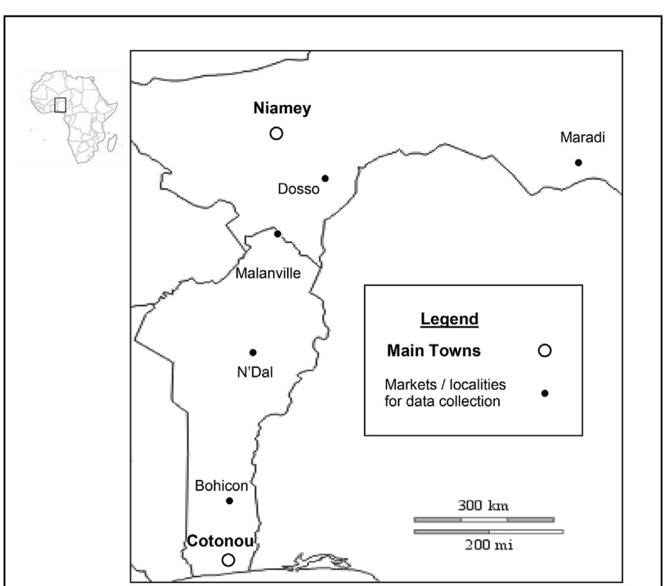

Fig. 1. Maize study localities in Benin and Niger.

focused on maize post-harvest management processes (drying, threshing, cleaning and winnowing) carried out before the crop storage. Grain moisture content was assessed using a Dickey-John (Dickey-John mini GAC plus Auburn, IL, USA) (http://www.dickey-john.com/product/mini-gac/) grain moisture meter after collecting and measuring three samples from batches of maize being stored by the interviewees. A sample of 500 g of their stored maize was collected for later assessment of grain quality.

Samples of maize to be assayed for aflatoxin were collected using a fresh pair of disposable Latex gloves for each sample. Approximately 200 g of grain were taken and then separated into two samples of 100 g each. These subsamples were repackaged individually in plastic bags and labeled as to date, location and vendor. One of the bags was submitted for aflatoxin analysis and the second was kept in the freezer for future verification, if necessary. Aflatoxin levels were determined by (ICRISAT) International Crops Research Institute for the Semi-Arid Tropics laboratory in Mali according to the protocols of CIMMYT and ICRISAT using the ELISA procedure (see http://www.icrisat.org/aflatoxin/elisa1.htm for details).

Pest density and grain quality of the maize samples was carried out as follows:

1. A jar was used to collect maize samples from the top, middle and bottom of the storage containers being used by the interviewee. The collected samples were thoroughly mixed and 500 g was saved and labeled for analysis;
2. Mesh sieves of 1 mm, 2 mm and 4.5 mm were used to separate broken grains and residues;
3. Live insects in each sample were identified and counted;
4. Impurities (non-consumables fraction) and mouldy or blackened seeds were separated and weighed to determine its relative proportion compared to the original sample weight.
5. The following formulae were used;
   i. Impurity level % = (weight of impurities/total sample weight) x 100;
   ii. Mouldy grain content % = (weight of mouldy seeds/total sample weight) x 100.

Analysis of variance followed by LSD tests were used to compare means related to moisture levels, percentage of impurities, proportion of mouldy grains, insect density (number of live insects per sample) and aflatoxin level, comparing the different classes of sellers (wholesalers, retailers and producers). Correlation coefficients (Pearson R) between the levels of aflatoxin and the proportion of the impurities, the percentage of mouldy grains and insect density were calculated. Statistical analysis was done with the Statistical Package for the Social Sciences (SPSS) Version 16.0, IBM (Chicago, Illinois).

3. Results

We collected 112 maize samples, 90 in Benin and 22 in Niger (Table 1). In Benin, 33 samples were obtained from wholesale traders, 33 others with retailers and 24 from producers. In Niger we collected 11 samples from wholesalers and 11 from retailers. Samples from Malanville, N'Dali, Dosso and Maradi were for the 2012 harvest year and from Bohicon for the 2013 harvest year.

Postharvest practices in use: 1) Drying: all respondents dry their crop in the household yard by exposing it to the sun on bare soil, on the roofs of the houses, on the edges of the paved roads, or in another cleared area. These methods are used for shelled maize. Reported drying times varied from 7 to 15 days; 2) Threshing: all respondents used the traditional method, beating the cobs with clubs or using mortars and pestles; 3) Cleaning and winnowing: