Occurrence of Fungal Growth in the Traditionally Processed Cassava Produces in Lushoto, Rorya and Ukerewe Districts

Chacha, J. and D.P. Mamiro

Department of Crop Science and Horticulture, Sokoine University of Agriculture, P.O. Box 3005, Morogoro, Tanzania

Corresponding author e-mail: *mamirodelphi@gmail.com*

Abstract

The study was conducted in Lushoto, Rorya and Ukerewe districts of Tanzania on cassava processing and drying methods; storage and fungal growth on cassava products. One hundred and twenty (120) households were interviewed on cassava processing and storage methods. Cassava products samples were collected for laboratory fungal growth analysis. 'Udaga' was the only final cassava product produced from cassava roots from all three districts. 'Udaga' is a cassava product traditionally produced by peeling cassava roots, solid fermented once or twice and direct or indirect sun-dried. Cassava products were fermented by either heaping under roof, or on rock surface, or on cemented floor, in 'tenga' and in polypropylene bags. 'Tenga' is a big busket made of bamboo-wood-sliced stems with holding capacity ranging from 10-50 kg. The whole fermentation process took 18 days. During fermentation, cassava was covered either by banana leaves, or tree leaves, or cassava peels, or old cloth, or cactus leaves, or polythene sheets and sometimes left uncovered. Cassava products were dried for 12-196 h indirectly or on direct sun. The cassava products were stored for less than one month (52.5%), 1-2 months (36.7%), 3-4 months (7.5%), and 5-6 months (3.3%). The storage methods/tools mostly used for storing cassava product for more than one month were polypropylene bags (28.3%), platform-like/under roof (15.0%) and plastic containers (4.2%). The study noted that traditional methods of cassava processing which included fermentation, produced poor quality (unhygienic) 'udaga' which was associated with fungal growth. The fungus Rhizopus spp. was the most prevalent (59.2%) followed by Cladosporium spp. (51.7%), Penicilium spp. (38.3%), Fusarium spp. (36.7%), Aspergillus spp. (20.0%) and yeast (10.8%). Other fungi observed were Curvularia spp. (4.2%) and Mucor spp. (4.2%). The study noted that traditional methods of cassava processing produced poor quality (unhygienic) 'udaga' in the study areas.

Keywords: Processing methods, cassava, storage methods, udaga

Introduction

Cassava (*Manihot esculenta* Crantz) is an important crop grown for staple food and income generation in Tanzania (Rwegasira and Rey, 2012). It has stable yields especially in the semi-arid areas where cereals fail due to drought and low soil fertility. Main cassava producing areas in Tanzania include: the coastal strip along the Indian Ocean (48.8%), around Lake Victoria (23.7%) and along the shores of Lakes Nyasa (13.7%) and Tanganyika (7.9%). In these areas, cassava is regarded as the first or second staple food (Gegios *et al.,* 2010; Mtunda *et al.,* 2002). Cassava is used in fresh and dried products such as flour form for making various dishes in most villages including alcoholic beverages in few villages (COSCA Tanzania, 1996). Generally, cassava is sun-dried on open air like on bare ground, on the shoulders of paved roads and on flat rooftops. During rainy season the cassava may not dry easily due to high humidity, inadequate sunshine and exposure to rainy that enhance mould growth and mycotoxin formation. The cassava products are stored in granaries, bare ground or floor and in the huts. The safety and quality of cassava products is usually inadequately assured because of various storage pests including moulds infection which may results in contamination with mycotoxins (FAO, 2005).

Despite its importance in the food system, cassava production is declining due to pests, management factors and poor post-harvest handling techniques at farm level (COSCA Tanzania, 1996). Unprivileged processing and storage leads to cassava products quality deterioration. The deterioration makes the products unfit for marketing, household and public consumption. Bankole and Adebanjo (2003); pointed out that poor physical quality, chemical contamination, bacterial or mycotoxins contaminations are some of the factors that threat the food quality and safety. Likewise Manjula *et al.* (2009) reported that the low quality and safety of foods in Africa have a significant impact on human and animal health, and are a major constraint to growers who need access to more remunerating markets.

Cassava is a liable substrate to fungal flora development (Essono *et al.,* 2007) if unhygienically processed and stored. Fungi found colonizing food are classified into field fungi and storage fungi based on their ecological requirements for growth (Bankole, 1994). The field group requires grain moisture above 20% in cereals and often causes ear rot diseases and toxin production before harvest, when the crop is still in the field. The important genera of field fungi include *Fusarium*, *Cladosporium* and *Alternaria* (Bankole and Adebanjo, 2003). The storage fungi usually grow in grains and other produce with moisture content in equilibrium with 70-90% relative humidity, which corresponds to less than 18% moisture content in cereals, and the most important species of the genera *Aspergillus* and *Penicillium.* They are infrequently associated with crops in the field, but are also associated with plant debris, plant surfaces, atmosphere and other surfaces where the water activity is relatively low (Mohana and Raveesha, 2007). Tanzania has tropical climate with all year round high ambient temperature and relative humidity that provide optimal condition for the growth of moulds.

This study focused on assessment of processing methods, drying duration and storage conditions of cassava products and its association to fungal infection in Lushoto, Rorya and Ukerewe districts. The fungi from stored cassava products were isolated and identified.

Methodology

The study was conducted in the districts of Lushoto (Tanga region, 4°25’-4°55’S and 30°10’-38°35’E), Rorya (Mara region, 10°00’-10°45’S and 33°30’-35°00’E) and Ukerewe (Mwanza region, 1°45’ - 2°15’S and longitude 32°45’-33°45’E). Lushoto district experiences bimodal rainfall pattern (October to December short rains and March to June long rains) ranging from 500 to 2000 mm per annum. Rorya district is located in the Northern Western part of Tanzania with an altitude ranges between 800-1,200 m.a.s.l and temperatures varying from 14°C-30°C. The annual rainfall ranges between 700 to 1200 mm per annum with unimodal rainfall regime beginning from February to May with occasional unpredictable short rains in September to December (around Lake Victoria). Ukerewe district is an island in the Lake Victoria which receives a bimodal rainfall (October-December, February - May) ranging from 900 mm to 2000 mm annually, temperature ranging between 21°C and 28°C and relative humidity of 35% to 60%.

A questionnaire was administered to 120 cassava growing farmers from 17 villages of Lushoto, Rorya and Ukerewe. The questionnaire requested information on cassava processing methods, drying duration and storage methods. During questionnaire administration, 120 cassava processed samples were collected whereby 40 samples were obtained from each district. Sampling was performed according to Kaaya and Eboku (2010) and 1 kg cassava processed products were obtained from each household. The samples were transported to

Sokoine University of Agriculture laboratories where microbial growth analyses were performed.

The standard blotter method was used to detect a wide range of fungi present in the cassava samples (Anonymous, 1976). Two hundred and fifty grams (250 g) of cassava products from each sample were milled then 1 g was placed on moistened sterile blotter papers (5 ml sterile distilled water) in 90 mm diameter Petri dishes in triplicates. The Petri dishes with samples were incubated for 7-14 days at 25°C in the dark to provide ideal conditions for fungal growth and sporulation. Fungi were identified to the genus level by macro and microscopic characteristics using keys described by Pitt and Hocking (1999) after observation under compound microscope (Leica MS5 Brunel microscopes Ltd. Input 230V~50Hz, bulb type 6V 20W, fuse 250V 0.5A F). The percent incidence of fungal genera was determined by dividing the number of positive samples for the genus by the total number of sample of cassava products analysed (Essono *et al.,* 2007).

Data from this study were analysed using SPSS 16.0 for windows computer software. Descriptive statistical analysis was carried out by using a sub-programme "Frequencies" for univariate analysis to obtain variabilities of dependent and independent variables. In frequency distribution tables, number of respondent farmers falling in particular attributes and their respective percentages were shown.

Results

Traditional methods of cassava processing used various techniques to produce 'udaga' through solid fermentation. There were minor differences in traditional processing methods, duration and size of 'udaga' among districts. Cassava processing in all three districts: Ukerewe, Lushoto and Rorya was through peeling of cassava roots, sun-dry for 1-10 h followed by heaping on the floor or rock surface or put in polypropylene bags and covered with tree leaves, banana leaves, grasses, old fish or mosquito nets, old clothes (here, old cloth means the cloth that is torn and can no longer be worn and old fish/mosquito nets are torn nets), fold in polyethylene and polypropylene sheets or heaping in polypropylene bags or 'tenga' and allowed to ferment for 2-7 days. During this period, the fungi grew on cassava root pieces and become soft. At this point, this cassava product is called *'mbute'* in Rorya district. The fermented cassava pieces were then scraped off to reduce the fungi and then crushed. The cassava products sometimes were then subjected to the second fermentation for 1-5 days, followed by sun-drying for 1-4 days depending on the sun intensity. Some farmers were skipping second fermentation by sun-drying peeled cassava roots 6-8 h, ferment for 3-4 days then scrap to reduce mould and crush followed by sun-drying again for 1-2 days. In case of shortage of food or high demand of cassava products in the market, short-cut method was applied whereby cassava roots were peeled, chopped and fermented for 3-4 days and then sun-dried for 1-2 days or cassava roots were peeled, fermented for 3-4 days, then fermented, chopped and finally sun-dried for 1-2 days to obtain udaga in rough small to large bolls size (Fig. 1). The 'udaga' has different names in this district depending on ethnic group, for example, *'konzo'* by Luo, *'obhotagha'* by Simbiti and *'amaghoshe'* by Kurya. The udaga ranged from whole or halved cassava roots to smooth small-sized boll to flour-like form (Fig. 1).

This study found that a complete common traditional processing of cassava took about 6-18 days in Lushoto, 6-5 days in Rorya and 2-4 days in Ukerewe district. The cassava products were milled to flour singly or mixed with maize, millet and or sorghum at various ratios. The flour was the staple food for household and was used to prepare stiff porridge (ugali), the dish which had different names based on ethnic groups in the location, for example, *'bada'* in Lushoto and *'ubhukima'* in Rorya. Stiff porridge was consumed with various relishes.

Drying of cassava products

The methods used to dry cassava products reported by framers in all districts are presented in Table 1. Farmers in Rorya and Ukerewe (100%) dried cassava by direct sun-drying. In

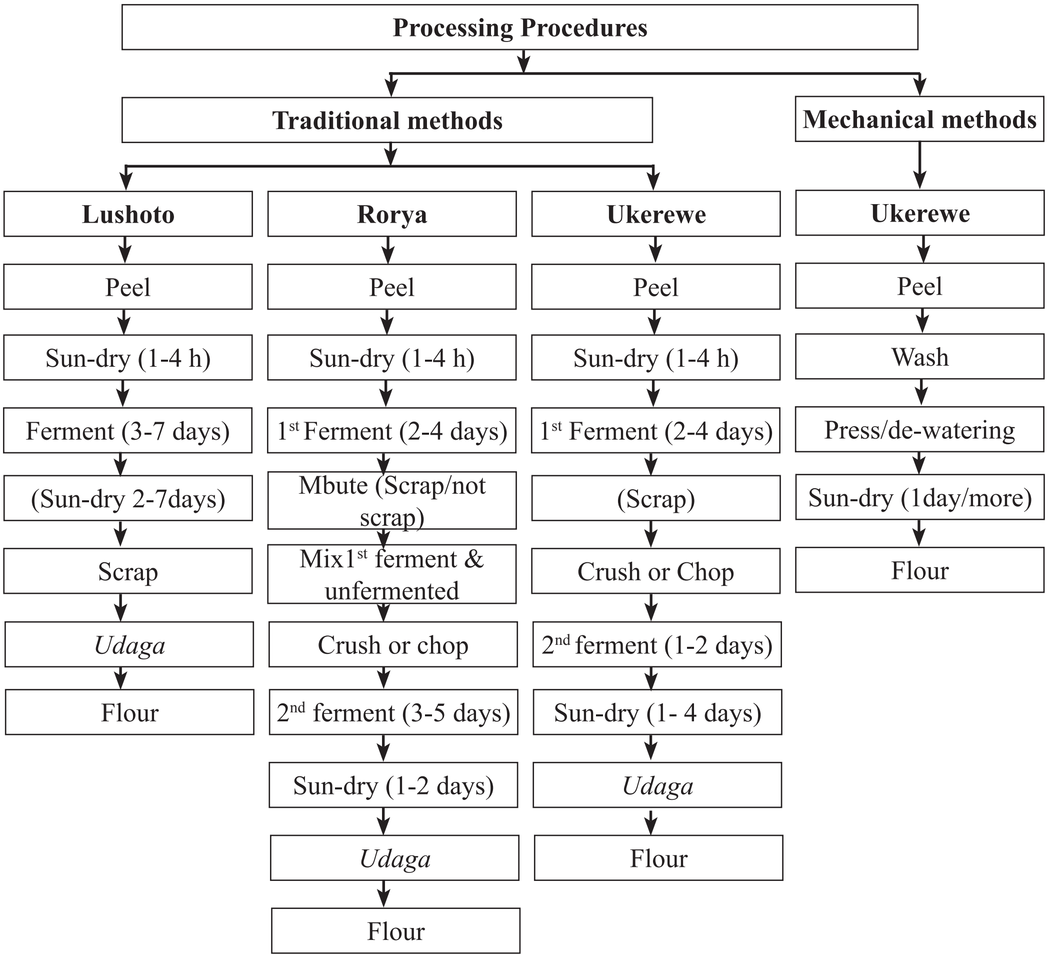

Figure 1: Steps in cassava processing in Lushoto, Rorya and Ukerewe districts, Tanzania

Lushoto, farmers dried cassava products by direct sun-drying (37.5%), spread under roof and smoke (20.0%), under roof only and direct sun-drying, under roof and smoke (17.5%) and direct sun-drying, under roof (7.5%).

The cassava products in Rorya were spread to dry on platform like under roof only (45%), roof constructed by iron corrugated sheet (32.5%) or on polypropylene sheet and (10.0%) on rock surface (12.5%). Overall, majority farmers dried cassava products on rock surface (55.0%) followed by on platform placed under roof (15%), and on roof made of iron corrugated sheet (10.8%) (Table 1).

The results from this study showed that farmers in all districts (77.5%), dried cassava between 12 to 48 h (Table 1). Few farmers (17.5%, 4.2% and 0.8%) dried cassava products between 49 to 85 h, 86 to 122 h and 160 to 169 h respectively. Farmers dry cassava between 12 to 48 h in Rorya (100%), Ukerewe (95%) and Lushoto (37.5%). The respondent farmers in Lushoto and Ukerewe districts reported that the drying durations of cassava products were protracted during rainy seasons. In Ukerewe district, the rain interfered the drying duration of cassava products. It caused the cassava products to be shifted from the rain to the shelter for a certain period and then returned back on the sun for drying after the rain or the following day depending on weather condition. The under roof drying was the other cause of extended drying period in Lushoto district because the cassava products were not getting direct sunshine. These conditions promoted mould growth on the cassava products.

Table 1: Cassava products drying methods

Parameter	Category	Lushoto (N=40)	Ukerewe (N=40)	Rorya (N=40)	Mean
		%	%	%	%
Drying methods	Direct sun-dry	37.5	100.0	100.0	79.2
	Under roof	17.5	0.0	0.0	5.8
	Under roof and smoke	20.0	0.0	0.0	6.7
	Direct sun-dry and under roof	7.5	0.0	0.0	2.5
	Direct sun-dry, under roof and smoke	17.5	0.0	0.0	5.8
Drying materials	Polypropylene sheet	10.0	12.5	10.0	10.8
	Rock surface	77.5	75.0	12.5	55.0
	Roof made of iron corrugated sheet	0.0	0.0	32.5	10.8
	Platform placed under roof	0.0	0.0	45.0	15.0
	Cloth	7.5	0.0	0.0	2.5
	Cemented floor	2.5	12.5	0.0	5.0
Drying duration (hours)	12-48	37.5	100.0	95.0	77.5
	49-85	47.5	0.0	5.0	17.5
	86-122	12.5	0.0	0.0	4.2
	160-196	2.5	0.0	0.0	0.8

Storage of cassava products

The results obtained from respondent farmers on storage methods and duration for cassava products are presented in Table 2. Generally, most farmers (50.8%) consume fresh cassava in all study districts. More than 50% stored cassava products for less than one moth. More than 7% of farmers were storing cassava products between 3-6 months (Table 2).

Farmers stored cassava products by heaping under roof in Lushoto (45%), Ukerewe (45%) and Rorya (20%). Storage containers used were polypropylene bags (20%) in Lushoto and plastic containers in Ukerewe (10%) and Rorya (2.5%). Generally cassava products were stored in farmers' houses or shelter made of bricks, mud and or wooden structure with earth or cemented floor thatched with iron corrugated sheets and or grasses. Some storage structures were not well thatched so they were found leaking and therefore caused growth of microorganisms on the stored cassava products.

More than fifty percent (52.5%) of cassava products of samples collected from farmers in these districts were stored less than 1 month. Cassava products were stored for 1 to 2 months (36.7%), for 3 to 4 months (7.5%) and for 5 to 6 months (3.3%). Numerous cassava samples were stored for less than one months in Rorya (75%) and for 1 to 2 months in Ukerewe(52.5%) and Lushoto (42.5%); and for fewer months in Rorya (15%). Cassava products (12.5%) in Lushoto, (7.5%) in Rorya and (2.5%), in Ukerewe were stored for 3 to 4 months. Only some cassava samples (7.5%) in Lushoto and (2.5%) in Rorya were stored for 5 to 6 months. Reason given by farmers for not storing cassava products were shortage of food (high demand of food than supply). Cassava could not be stored for longer period of time without being destroyed by insects and other storage organisms.

Table 2: Storage of cassava products

Parameter	Category	Lushoto (N=40)	Ukerewe (N=40)	Rorya (N=40)	Mean
		%	%	%	%
Storage method	Fresh consumption (no storage)	77.5	45.0	30.0	50.8
	Under roof	0.0	0.0	50.0	16.7
	Polypropylene bags	20.0	45.0	20.0	28.3
	Plastic containers	2.5	10.0	0.0	4.2
Storage duration (months)	Less than one month	75.0	45.0	37.5	52.5
	1-2	15.0	52.5	42.5	36.7
	3-4	7.5	2.5	12.5	7.5
	5-6	2.5	0.0	7.5	3.3

Occurrence of fungal growth in cassava products

Results of the occurrence of different fungal genera isolated and identified from cassava products are indicated in Table 3. The results showed that *Rhizopus* spp. were the most prevalent (59.17%) fungi followed by *Cladosporium* spp. (51.67%), then *Penicillium* spp. (38.33%), *Fusarium* spp. (36.67%), *Aspergillus* spp. (20.0%), yeast (10.83%) and 4.17% for both *Mucor* spp. and *Curvularia* spp. These fungi were isolated from cassava products in all districts except *A. niger* which was missed in casssava products from Lushoto. Also *Mucor* spp. was not isolated from Rorya samples and *Curvularia* spp. was missed in Ukerewe samples.

Discussion

The study found that farmers harvest, process and store cassava products for future consumption and other uses. The main processing period in Lushoto and Rorya districts was during dry season when there was adequate sunshine and less rain for easy drying of cassava products. In Ukerewe district farmers used to process cassava products during rainy season because it was the season with cheap labour. The same labour force was used for cassava processing and land preparation for other crops. This cassava processing time exposes the produce to the wet weather conditions. During rainy seasons the cassava products may not dry easily due to high humidity, inadequate sunshine and exposure to rain. The survey showed that farmers practiced

Table 3: Occurrence of fungal genera in cassava products

Fungal species	Lushoto (N=40)	Ukerewe (N=40)	Rorya (N=40)	Total (N=120)
	%	%	%	%
Aspergilus spp.	20.0	27.5	12.5	20.00
Cladosporium spp.	65.0	50.0	40.0	51.67
Curvularia spp.	7.5	0.0	5.0	4.17
Fusarium spp.	35.0	32.5	42.5	36.67
Mucor spp.	7.5	5.0	0.0	4.17
Penicillium spp.	50.0	35.0	30.0	38.33
Rhizopus spp.	70.0	47.5	60.0	59.17
Yeast	2.5	10.0	20.0	10.83

both traditional and mechanical methods of cassava product processing whereby solid state heap fermentation under roof (indirect sun-drying) and direct sun-drying of cassava products were performed. Likewise, Manjula *et al.* (2009) and Westby *et al.* (2002) reported that in Mtwara, Mkongi and Unguja cassava chips and flour were sometime processed by fermentation as one of the traditional methods.

In Ukerewe cassava products were processed in smooth, small-sized bolls to flour-like form, while in Rorya they were processed in small to large bolls but bigger than Ukerewe and whole or halved cassava roots in Lushoto but all were regarded as 'udaga'. Mkamilo (2005) reported that in Tanzania, traditional cassava processing is common whereas various techniques are used to produce different processed products from one place to another depending on the intended use of the end product. The survey in these districts noticed that in traditional methods, the harvested cassava roots were peeled and might be cut into varying sizes, dried directly on the sun on bare ground or other drying materials or heaped to ferment before the drying process. During fermentation fungi grew on cassava root surface with white, black, green or orange colouration.

Generally, in Lushoto district cassava products were dried while retaining the fungal growth until the time of preparation for milling when they were scraped off. Sometimes in Rorya district, fermented cassava roots were dried and milled for food without scrapping off the fungi which grew during fermentation. Similarly, the same observation by Wereing *et al.* (2001) reported mold growth on dried fermented cassava product (kokonte) in Ghana. Likewise, Kaaya and Eboku (2010) reported mold growth on fermented cassava roots in Kumi districts, Eastern Uganda. The processing tools might be the source of inocula transmission, the scraping knives are not sterilized after each scrapped root and sometimes the processing tools are being exchanged from one household to another.

This survey revealed that cassava products form and size were the results of harvesting season and end user preferences. The cassavas harvested at dry season were in large bolls, some pieces to whole roots and those harvested during rainy season were in small bolls to flour-like. For example, majority of cassava products were crushed into small bolls to flour-like especially in Ukerewe district as aid of fast drying, small to large bolls in Rorya and some pieces or whole roots in Lushoto, although the fermented cassava were likely to be crushed. Crushing is experienced when the drying is to be achieved fast (Kaaya and Eboku, 2010). Out of farmers preference cassava products would be in flour form due to shifting of crushed cassava product from rain and return back to the sun which enhanced breaking from bolls into flour-form. Similarly heaping of cassava products that are not thoroughly dried leads to heat emission the situation that boost breakage of cassava bolls into flour-form.

The survey further revealed that cassava roots were dried on bare ground by many farmers and 50% of the farmers dry cassava products on rock surface. Other farmers dried cassava products on rusty iron sheet roof and platform-like (under roof only). Very few farmers dry their cassava products on polypropylene sheets and cemented floor. Other materials found to be used for drying cassava products were iron vessels, dry grass or grass thatched roof (pieces or whole cassava roots), cattle hides, cloths like bed sheets and khanga. The result in this survey is reliable with Kaaya and Eboku (2010) who reported that cassava had been dried on rock surface by many farmers and very few on polyethylene sheets or concrete paved surfaces in Kumi district-Eastern Uganda. Similarly, FAO (2005) reported that cassava in Uganda is dried on any open surface including bare ground, bare rock and on shoulders of roads. Poor drying material may be caused by financial crisis of the farmers in Tanzania which hold up the failure of purchasing improved drying materials like polyethylene sheets and or cemented floors. Kaaya and Eboku (2010) reported that drying cassava on bare ground, rock surface and shoulder of roads was attributed to the low income status of the farmers in Uganda.

Drying of cassava roots on the bare ground or any other materials rested on ground like polypropylene, bed sheets and khanga exposes the cassava to contamination with soil, dust, fungal spores and other foreign materials. Exchanging of drying materials like polyethylene sheet among farmers may be the source of inocula dissemination especially when one farmer among the chain has contaminated cassava products. Generally, rock surface and cemented floor are neither cleaned nor sterilized for life in many areas; they may be also the sources of inocula.

This study noticed that cassava products had been dried for 12 to 170 h depending on weather condition and methods of drying. Rainy, cloudy, misty and high atmospheric relative humidity delayed drying of cassava products in Ukerewe district. Likewise indirect sun-drying (under roof) prolonged drying duration of cassava products in Lushoto district, hence chance for microbial growth. Delay in drying period may promote microbes and insect infestation and can lead to discolouration and changes in flavour (Knoth, 1993; Magan and Aldred, 2007).

Generally, in Lushoto, Rorya and Ukerewe districts cassava products were being stored in farmers' houses or shelter (used as house and kitchen) made of bricks, mud and or wooden structure with earth or cemented floor thatched by iron sheets and or grasses. The floor of the storage structures were made of earth or cement and thatched with iron corrugated sheets or grass. The reason of storing cassava in houses or shelters was to avoid theft of their food. Similarly, Eisen *et al.* (2013) and Kaaya and Eboku, (2010) showed that most farmers in Kumi stored dried cassava in the huts which double as housing and kitchen in order to protect the produce against theft. Fandohan *et al.* (2005) reported that such structures are built using mud and wood and may have little or no ventilation. Mestres *et al.* (2004) observed that heaps of yam chips in a poorly ventilated room was not favourable for moisture loss and favoured mold growth and insect infestation. In these structures cassava products were being stored in polypropylene bag, heaped under roof and in plastic containers in Lushoto, Rorya and Ukerewe districts. Likewise Kaaya and Eboku (2010) mentioned that cassava was either heaped or stored in various containers like Jerri cans, clay pots or polypropylene bags in Kumi district - Eastern Uganda.

While farmers in Ghana were reported to store kokonte, a dried fermented cassava product for up to 3 months (Wereing *et al.,* 2001), majority of farmers in Lushoto, Rorya and Ukerewe districts stored cassava products for 1-2 months. The study reveals that most cassava products processed traditionally in these districts are poor in quality and low in safety. Due to lack of awareness on the effect of mouldy food products, farmers were consuming cassava products. The study by Magembe *et al.* (2016) showed that farmers were consuming fungal infected food produce which might have been contaminated with mycotoxins due to lack of knowledge. Currently, poor quality and safety of cassava products is attributable to poor processing techniques, which are a draw back in the exploitation of market (Mkamilo, 2005).

The results established that cassava had been contaminated by a number of fungal species. *Rhizopus* spp., *Aspergillus* spp., *Cladosporium* spp., *Penicillium* spp., *Fusarium* spp., *Mucor* spp., *Curvularia* spp., and yeast have been isolated from 120 samples of cassava products collected from Lushoto, Rorya and Ukerewe districts. Likewise, Kaaya and Eboku (2010) observed *Rhizopus*, *Mucor*, *Penicillium*, *Aspergillus* and *Fusarium* species in cassava products in Kumi district, Uganda. Essono *et al.* (2007) also recovered 13 species of *Aspergillus* from 72 samples of dried cassava chips from Cameroon. Wareing *et al.* (2001) isolated predominantly *Fusarium* spp. on Ghanaian cassava chips and to a lesser extent *Aspergillus* and *Penicillium* spp.

The variation in methods of processing of udaga, storage and geographical conditions might be cause of variation of Occurrence of fungi in these districts. These fungal species are mostly related with processing and storage practices. In traditional methods, the cassava roots were fermented for an average of 4-6 days (majority). Sometimes fermented cassava roots (*mbute*) were dried and milled for food mixed with other cereals or without mixing and retention of fungal growth in Rorya. During rainy seasons the cassava products would not dry easily due to high humidity, inadequate sunshine and exposure to rain. Wereing *et al.* (2001) reported mold growth on dried fermented cassava products (*kokonte*) in Ghana. Likewise, Kaaya and Eboku (2010) reported mold growth on fermented cassava roots in Kumi districts, Eastern Uganda.

Peeling of cassava roots removes the natural protective tissues, the process that expose the inner part to contaminants. Liu *et al.* (2006) and Udoh *et al.* (2000) reported that natural protection such as grain husks has been reported to protect maize and rice from weevils and mold infestation and aflatoxin contamination. This kind of defense is not available in cassava after peeling and processing into cassava products making them susceptible to attack by fungi. Drying of cassava roots on the ground or any other materials rested on ground like bed sheets and khanga exposes the cassava to contamination with soil, dust and fungi spores. Cassells (1990) proved that *Fusarium* spp., *Penicillium* spp. and *Aspergillus* spp. were exogenously found in soils, water and plant surfaces. Msogoya *et al.* (2012) observed that *Aspergillus, Fusarium*, *Penicillium* and *Candida* were the main fungal contaminants of banana in vitro cultures. Similarly, *Fusarium* has been reported as an endophytic fungus in banana and pumpkin plants while *Penicillium* spp. and *Aspergillus* spp. were found in internal tissues of mallow plants (Suryanarayanan *et al.,* 2000; Odutayo *et al.,* 2007).

Conclusion

Traditional cassava processing by many farmers resulted to poor quality udaga, that might be hazardous to consumers. So education on how to process high quality udaga and storage is very crucial to cassava growers and processors. This research has shown that cassava products in these districts also were infected with fungi. Some fungi, for example *Aspergillus* spp. and *Fusarium* spp. are known for production of mycotoxins such as aflatoxin and fumonisins respectively.

We recommend that capacity building to farmers should be availed on how to improve cassava processing traditionally and mechanically to obtain products which are mould-free. Cassava products should be sampled from time to time to analyse presence of fungi and the possibility of mycotoxins for safer food in the households.

Acknowledgments

The partial financial support given by IITA-Tanzania to carry out this study is highly appreciated.

References

Anonymous, (1976). International rules for seed testing. Proceedings of the International Seed Testing Association 32: 562-598.

Bankole, S.A., (1994). Changes in moisture content, fungal infection and kernel germinability of maize in storage. International Journal of Tropical Plant Diseases 12: 213-218.

Bankole, S.A. and Adebanjo, A., (2003). Mycotoxins in food in West Africa: current situation and possibilities of controlling it. African Journal of Biotechnology 2: 254-263.

Cassells, A.C., (1996). Production of healthy plants. In: proceedings of the Institute of Horticultural Symposium: Micro propagation in culture. Alerson P.G., Dullforce, W.M. (edition). Nothingham. University of Nottingham Trent Print Unit. pp. 53-71.

Collaborative Study of Cassava in Africa (COSCA) Tanzania, (1996). Production prospects for Cassava in Tanzania (draft). COSCA Working paper No. 16. Collaborative Study of Cassava in Africa, International Institute of Tropical Agriculture (IITA) and Ministry of Agriculture, Tanzania.

Eisen, R.J., Enscore, R.E., Atiku, L., Zielinski-Gutierrez, E., Mpanga, J.T., Kajik, E., Andama, V., Mungujakisa, C., Tibo, E., MacMillan, K., Borchert, J.N. and Gage, K., (2013). Evidence that rodent control strategies ought to be improved to enhance food security and reduce the risk of rodent-borne illnesses within subsistence farming villages in the plague-endemic West Nile region, Uganda. International Journal of Pest Management 59(4):259-270. DOI: 10.1080/09670874.2013.845321.

Essono, G., Ayodele, M., Akoa, A., Foko, J., Olembo, S. and Gockowski, J., (2007). Aspergillus species on cassava chips in storage in rural areas of southern Cameroon: Their relationship with storage duration, moisture content and processing methods. African Journal of Microbiology Research 1:1-8.

Fandohan, P., Gnonlonfin, B., Hell, K., Marasas, W.F.O. and Wingfield, M.J., (2005). Impact of indigenous storage systems and insect infestation on the contamination of maize with fumonisins. African Journal of Biotechnology 5: 546-552.

Food and Agricultural Organization (FAO) (2005). A review of cassava in Africa with country case studies on Niger, Ghana, the United Republic of Tanzania, Uganda and Benin. Validation Forum on the Global Cassava Development Strategy, April 26-28, FAO, Rome, Italy.

Gegios, A., Amthor, R., Maziya-Dixon, B., Egesi, C., Mallowa, S., Nungo, R., Gichuki, S., Mbanaso, A. and Manary, M.J., (2010). Children consuming cassava as a staple food are at risk for inadequate zinc, iron and vitamin A intake. Plant Foods for Human Nutrition 65(1): 64-70.

Kaaya, A.N. and Eboku, D., (2010). Mould and aflatoxin contamination of dried cassava chips in Eastern Uganda: Association with traditional processing and storage practices. Journal of Biological Sciences 10: 718-729.

Knoth, J., (1993). Traditional Storage of Yams and Cassava and its Improvement. TZ-Verlag, Rossdorf, Humburg, Germany, pp: 116.

Liu, Z., Gao, J. and Yu. J. (2006). Aflatoxins in stored maize and rice grains in Liaoning Province, China. Journal of Stored Products Research 42: 468-479.

Magan, N. and Aldred, D., (2007). Post-harvest control strategies: minimizing mycotoxins in the food chain. International Journal of Food Microbiology 119(1-2): 131-139.

Magembe, K.S., Mwatawala, M.W., Mamiro, D. P., Chingonikaya, E.E., (2016). Assessment of awareness of mycotoxins infections in stored maize (Zea mays L.) and groundnut (*Arachis hypogaea* L.) in Kilosa district, Tanzania. International Journal of Food Contamination 3: 12.

Manjula, K., Hell, K., Fandohan, P., Abass, A. and Bandyopadhyay, R., (2009). Aflatoxin and fumonisin contamination of cassava products and maize grain from markets in Tanzania and republic of the Congo. Toxin Reviews 28(2): 63-69.

Mestres, C., Bassa, S., Fagbohoun, E., Nago, M., Hell, K., Vernier, P., Champiat, D., Hounhouigan, J. and Cardwell, K., (2004). Yam chip food sub-sector: Hazardous practices and presence of aflatoxins in Benin. Journal of Stored Products Research 40: 575-585.

Mkamilo, G.S., (2005). Current status of cassava improvement programme in Tanzania. Paper presented in a workshop on molecular marker-assisted and participatory plant breeding held at Kunduchi Beach Hotel in Dar es Salaam, 12-16th September, 2005.

Mohana, D.C. and Raveesha, K.A., (2007). Anti-fungal evaluation of some plant extracts against some plant pathogenic field and storage fungi. Journal of Agricultural Technology 4(1): 119-137.

Msogoya, T., Kanyagha, H., Mutigitu, J., Kulebelwa, M. and Mamiro, D.P., (2012) Identification and management of microbial contaminants of banana in vitro cultures. Journal of Applied Bioscience 55: 3987-3994.

Muzanila, Y.C., Brennan, J.G. and King, R. D., (2000). Residual cyanogens, chemical composition and aflatoxins in cassava flour from Tanzanian villages. Food Chemistry 70: 45-49.

Odutayo, O.I., Amusa, N.A., Okutade, O.O. and Ogunsanwo, Y.R., (2007). Sources of microbial contamination in tissue culture laboratories in southwestern Nigeria. African Journal of Agricultural Research

2(3): 67-72.
Pitt, J.I. and Hocking, A.D., (1999). Fungi and Food Spoilage. 2nd (Eds.) Aspen Publishers Inc., Gaithersburg, MD. Resources, Environment and Cooperatives. Zanzibar.
Rwegasira, G.M. and Rey, C.M.E., (2012). Response of selected cassava varieties to the incidence and severity of cassava brown streak disease in Tanzania. Journal of Agricultural Science 4(7): 237-245.
Udoh, J.M., Cardwell K.F. and Ikotun, T., (2000). Storage structures and aflatoxin content of maize in five agroecological zones of Nigeria. Journal of Stored Products Research 36:187-201.
Wareing, P.W., Westby, A., Gibbs, J.A., Allotey, L.T. and Halm, M., (2001). Consumer preferences and fungal and mycotoxin contamination of cassava products from Ghana. International Journal of Food Science and Technology 36: 1-10.
Westby, A., (2002). Cassava utilization, storage and small-scale processing. In Hillocks, R.J., Thresh, J.M. and Bellotti, A.C. (Eds), Cassava biology, production and utilization. CABI Publishing, Wallingford, UK, 281-300.