

## Assessment of Microbiological Qualities of Yam Chips Marketed in Togo

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**Abstract:** Yam is one of the most staple foods in West African countries and provides an important part of the energetic for peoples. The fresh tuber contains a lot of water that makes its preservation very difficult. This study was undertaken to assess the health risk of yam chips obtained from the traditional draw-plate consisting of transforming the fresh yam tuber into dehydrated product (dried yam) known as “cossettes” which is less perishable and propose strategies to control risk points. The approach of HACCP (Hazard Analysis Critical Control Point) concept using the standardized routine methods adopted in the UEMOA (West African Economic and Monetary Union) countries allowed us to do microbiology’s assesses. The results of this study showed that the yam chips are contaminated to various degrees by Mesophilic germs (*Bacillus* sp), coliforms and molds (*Aspergillus niger*, *Aspergillus flavus* and *Aspergillus glaucus*). Salmonella was not found. This bacteria and moulds isolated in the yam chips contain some species involved in food borne illness. The practice of dry yam chips was done to overcome the losses of the yam fresh tuber. The bad conditions of this work affect the hygienic qualities of dry yam, which can present the health risk of consumers.

**Key words:** Cossettes, dried yam, HACCP, microbiological qualities, yam

### INTRODUCTION

Yam is a basic foodstuff well appreciated in the tropical and humid regions of Africa, South America, India, South-East Asia (Degras, 1986; Ategbo, 1998; Achi, 2000) and in West Africa (Alfred, 1985; Bricas, 1998; Hodeba *et al.*, 2003; Mathew *et al.*, 2003; Sanni *et al.*, 2003; Okigbo and Nwakammah, 2005; Sanusi and Salimonu, 2006; Ijoyah *et al.*, 2006; Adegbite *et al.*, 2006; Chukwu *et al.*, 2007; Babajide *et al.*, 2007). Its role in food security is justified by its potential energy, its insensitivity to climatic (Bricas, 1998) and its adoption as a staple in Africa well before the introduction of new crops of the new world such as corn, cassava. Many species of yam are grown and are distinguished from each other by the colour of the flesh tubers, the morphology of leaves and stems of flowers and so on. (Okigbo and Nwakammah, 2005). The production of yams in the world in general and in West Africa in particular is constantly growing. The yam crops production according to Lawrence *et al.* (2006) was 40 millions tons. This production is important so that in harvest period, there was a temporary glut that exceeds the need of consumers. Excess production set subject to rot and slump because traditional conservation techniques are not effective (50% loss after 6 months of

conservation) while improved conservation techniques (Curing, application of gibberellins and ionizing radiation) are too expensive (Nindjin, 1998). To overcome the problems of loss and seasonal supply of yams, a transformation into chips was initiated by farmers. This is a craft transformation of matter into a fresh dehydrated by solar drying (Hounhouigan, 1998; Babajide *et al.*, 2007; Attai *et al.*, 1998).

Nowadays despite descriptive studies of traditional processing of yams chips, few studies are conducted to assess the impact of this traditional processing technology on the microbiological quality of resultant products. This study was undertaken to assess the impact of this transformation system on the quality of yam chips.

### MATERIALS AND METHODS

**Sampling:** The dried yam chips and yam tubers of the variety “Koukou, Laboko, kéki, Catala” (*Dioscorea cayenensis rotundata*) were collected in sterile polythene bags in April 2008:

**Est mono:** This region is located in zone III of ecological map of Togo and characterized by: a monomodal rainfall pattern with annual rainfall amounts ranging from 1400 to 1700 mm, a duration of the vegetative period of 270 days,

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an evapotranspiration of 1531 mm, a solar radiation per day than 442 cal/cm<sup>2</sup> and an annual average temperature ranging from 26 to 27°C.

**Bassar:** This region is located in zone IV of the ecological map of Togo and characterized by a monomodal rainfall pattern with annual rainfall amounts ranging from 1300 to 1500 mm, a duration of the vegetative period of 206 days an evapotranspiration of 1700 mm, a solar radiation per day than 500 cal/cm<sup>2</sup> and an annual average temperature ranging from 20 to 30°C.

**Processing of yam to dry-yam:** Yam tubers were processed to chips since May 2008 in the Microbiology Laboratory of Food stuff and Quality Control in the University of Lomé in the laboratory following two diagrams described during the survey with farmers. This Processing was to locate the input stage and proliferation of bacteria during the manufacture and to see which of the two diagrams is effective for obtaining chips of good hygienic quality. For this Processing, three varieties of yam are used (*Laboco*, *Keki* and *Koukou*). The two diagrams followed in this manufacture of experimental chips are:

**Diagram A:** This diagram is used in Bassar region and the most of northern Togo and Ghana. The tubers are peeled and cut into slices 0.5 to 1 cm in diameter and 5 to 10 cm length and before washing microbiological analysis is performed on fresh slices. This is to assess the microbial load of tubers at the origin. A second microbiological analysis is done on these slices washed before drying in order to assess the impact of washing on the evolution of the microbial load of tubers. The washed slices were divided into two lots. The first is dried in the sun and the other in the oven at 50°C.

**Diagram B:** This diagram is generally used in the Est-Mono region; Benin and Nigeria. The tubers are first peeled and cut into slices 0.5 to 1 cm in diameter and 5 to 10 cm in length. Before the pre cooking, microbiological analysis is performed on fresh slices. This is to assess the microbial load of tubers at the origin. A second microbiological analysis is done on these slices washed before pre cooking in order to assess the influence of washing on the evolution of microbial load. A third analysis was performed on these slices just after the pre-cooking and before drying to assess the impact of treatment of pre cooked on the evolution of the microbial flora. Finally, the slices are divided into two lots. The first is dried at 50°C in the oven and the other in the sun with ambient air. A final analysis is made on the two lots of chips.

Table I: Colombia criteria for the cassava flour

Germ sought	Criteria
Flora Total Aerobic (30°C)	2.10 <sup>5</sup>
Total coliforms (30°C)	10 <sup>2</sup>
Coliform Thermo-tolerants (44°C)	Not Recognized by the criteria
<i>Escherichia coli</i> (44°C)	0
Moulds and yeasts (30°C)	10 <sup>3</sup>
The Salmonella	0

#### Culture media:

- Plate Count Agar medium (Method of reference NF V08-051, 1999) for Mesophilic germs at 30°C
- Violet Red Bile Lactose Agar (Method of reference NF V08-050, 1999) for Total Coliforms and Thermotolerant Coliforms and *Escherichia coli* (44°C) C (Method of reference NFV08-050, 1999)
- Sabouraud Chloramphenicol Agar medium C (NF ISO 7954 - 1988) at 30°. For Yeasts and Moulds (30°C)
- Salmonella spp. Buffered Peptone Water (Pre-enrichment), Rappaport Vassiliadis soya Broth (Enrichment), Hektoen and Salmonella Shigella (Isolation) and Identification were researched by the Method of reference (NF V08-052, 1997)

**Microbiological analyses:** Microbiological analyses of dried yam chips and parboiling slices were microbiologically analysed. The microbiological procedures were those recommended in the standardized routine methods adopted in the UEMOA (West African Economic and Monetary Union) countries. Microbiological analyses included total aerobic germs count, fungal count, coliform count and *salmonella* sp. count.

**Enumeration of microorganisms:** In aseptic conditions, each sample is first reduced to pieces; then 10 grams of the product obtained was mixed with 90 mL of Tryptone Salt. After 20 to 30 min, the whole suspension was ground in a grinder of the waring blender. The suspension obtained constituted the stock solution of the sample from which a series of decimal dilutions going from 10<sup>-1</sup> to 10<sup>-5</sup> was performed

## RESULTS AND DISCUSSION

The Colombia criteria for the cassava flour proposed by the International Society for Horticultural Sciences (N° 375-November 1993) were used as the microbiological appreciation criteria of the results (Table I).

**Assessment of microbiological quality of chips collected from Bassar and Est-mono markets:** The assessment of microbiological quality according to the criteria used showed the following results in terms of compliance (Fig. 1).

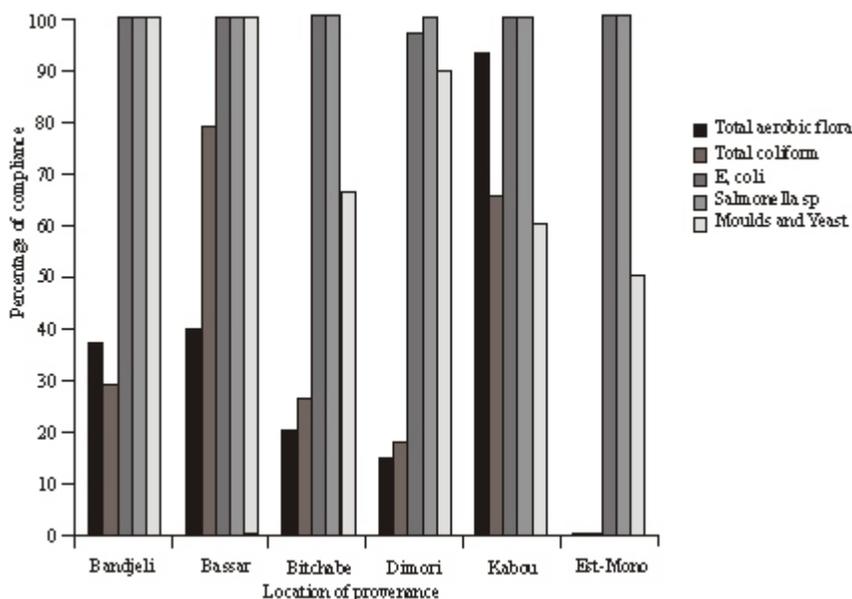


Fig. 1: Compliance compared with each germ

Compared with the total aerobic flora, a line of 93.33% for samples of Kabou was obtained, 39.39 and 36% respectively for Bassar and Bandjéli samples, 20% for Bitchabé samples and 14.63% for Dimori samples and 0% for East-Mono. Microbiological pollution and unhealthy in the areas of production, storage and sale of chips would be at the origin of these contamination.

According to total coliform, a line of 78.78% was obtained for Bassar, samples, 66.66% for Kabou 28% for Bandjéli, 26.66% for Bitchabé samples, 17.07% for Dimori, and 0% for the East-Mono. The coliform bacteria are indicators in breach of rules of hygiene. These levels of contamination recorded resulting from poor hygienic practices in the production of yam chips.

Compared with *Escherichia coli*, a germ heat tolerant, a line of 100% is observed in all samples except samples Dimori where it is 97.56. Contamination of faecal origin would be the source of this contamination. *Escherichia coli* is a germ usually present in the intestinal tract of humans and animals. His presence in the yam chips analyzed reflects a faecal contamination of recent origin. Compared to moulds and yeasts a line of 100% is obtained from samples taken at Bassar and Bandjéli compared with 90.24 for Dimori, 66.66% for Bitchabé, 60% for samples of Kabou and 50% for samples of Est Mono. The ill-drying is the cause of the contamination related to moulds and yeasts. These germs are responsible for deterioration of nutritional quality and taste of food and producers as toxins responsible for food poisoning infection.

Compared with salmonella, a line of 100% is observed in all the samples. Since salmonella are Gram-

negative bacilli producing toxins. Their absence in the yam chips could be a sign of microbiological quality product satisfactory subject to possible toxins produced by germs found sporogony (*Bacillus* sp.) and moulds. Similar studies conducted in Nigeria by Babajide *et al.* (2006), Bankole and Adebajo (2003), Bankole and Mabekoje (2004), Bassa (2001) and Adeyanju and Ikotun (1988), showed contamination by germs total coliforms and moulds and *Rhizopus* genus *Aspergillus*. Like us, these authors have not found salmonella in the yam chips studied.

Bassar region is located in zone III of the ecological map of Togo and characterized by a monomodal rainfall pattern with annual rainfall amounts ranging from 1300 to 1500 mm, a duration of the vegetative period of 206 days an evapotranspiration of 1700 mm, a solar radiation per day than 500 cal/cm<sup>2</sup> and an annual average temperature ranging from 20 to 30°C. Est- Mono is located in zone IV of ecological map of Togo and characterized by: a monomodal rainfall pattern with annual rainfall amounts ranging from 1400 to 1700 mm, a duration of the vegetative period of 270 days, an evapotranspiration of 1531 mm, a solar radiation per day than 442 cal/cm<sup>2</sup> and an annual average temperature ranging from 26 to 27°C.

This is the reason why the samples of Est - Mono region had the low percentage of conformity in comparison of those for Bassar region.

**Assessment of microbiological quality of chips collected from producers:** (chips test products with producers, Chips produced in rainy seasons and chips produced in harmattan season).

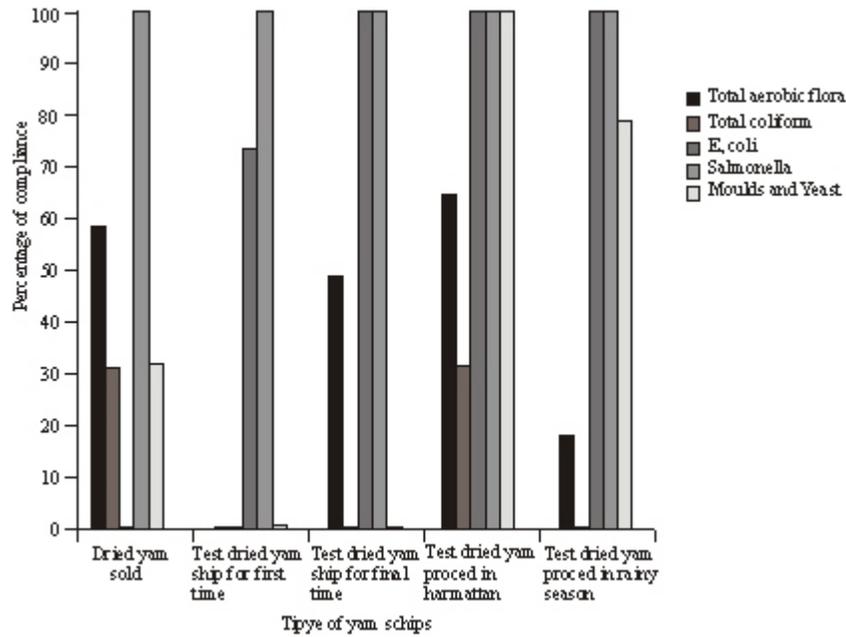


Fig. 2: Compliance compared with each germ

These results show that the test chips and those produced in the rainy season have poor hygienic quality in comparison with mesophilic bacteria with the respective conformities of 0, 50 and 20%. The drying during these periods being interrupted, all the germs find a favorable niche for their development in these products, which are not well dried (Fig. 2).

Compared to coliforms, the hygienic quality is also unsatisfactory for the same chips with values ranging from 0 to 33%. The Thermotolerant Coliforms were found in the samples analyzed with the values ranging from  $80.10^2$  to  $1200.10^2$  but the microbiological appreciation criteria used did not define the reference value of these germs. This contamination would be of faecal origin and linked with the failure to respect hygiene rules

Contamination by Moulds was also observed especially for the test chips and those produced in the rainy season a conformity ranging from 0 to 33%. This contamination would be due to the production, drying and preservation conditions as well as the insalubrity existing at storage places.

The yam tubers just as those of potatoes and cassava showed low contamination. The low microbial load of the tubers could be due to the fact that they are naturally protected by a thin layer of corky nature, which could also contain anti-microbial substances as Degras (1986) had already assumed.

The production test with the farmers allowed us to locate the critical points of the production. These points are: the drying stage and treatment before drying (washing and precooking).

**Assessment of microbiological quality of chips produced experimentally in the laboratory:**

These results show that the number of germs of sun-dried chips is higher than those of tubers and the oven-dried chips (Fig. 3). This clearly shows the influence of heat and the state of the environment drying. For oven drying, the environment is closed and not exposed to germs in the air. While sun-drying at ambient exposes chips to brew all drafts with airborne germs and their spores. Moreover, these germs are always in contact with them since sliced fresh until completely dry. This makes ineffective the effect of solar heat on the chips

This study was undertaken to assess the health risk of yam chips according to the HACCP (Hazard Analysis Critical Control Point) approach. The first approach is to analyze the potential risks of the technology transformation of yam chips. Thus, a collection of 122 samples of yam chips was done in markets of major yam producing areas including Bassar and Est- Mon region. The first approach reveals a microbiological risk to consumers. This risk is reflected by contamination at various degrees of chips sold by germs sought.

In a second approach, we wanted to demonstrate the levels and times of operation where the risks found in the first approach (contamination) may occur Thus, we followed the manufacturers of chips produced with them and collected samples of the main stages of production and those goods and canned before.

In a third approach, we produced the chips in the laboratory from the tubers of various species under different diagrams of production observed in the field to

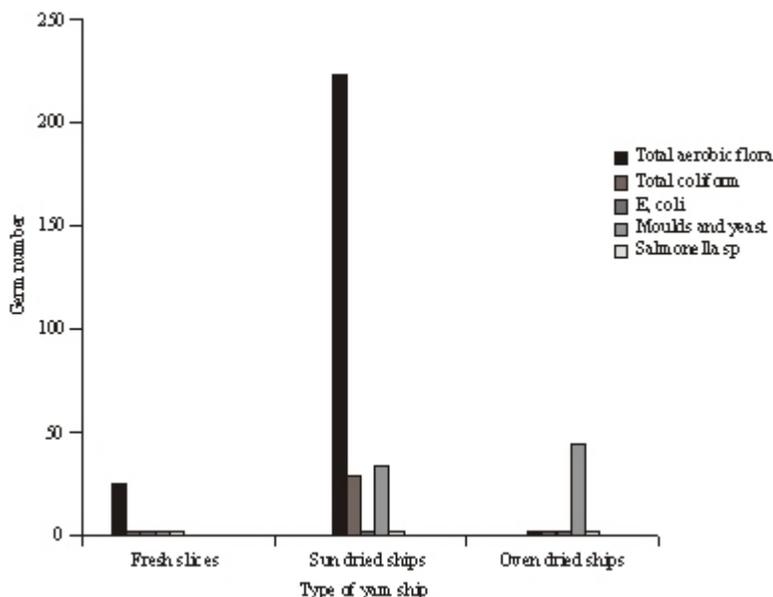


Fig. 3: Microbiological quality of experimental yam chips

control the risk items identified in the second approach by heat treatment and disinfection rinse.

With the absence of *Salmonella* (pathogenic germs) in the dried yam chips the latter can be eaten without danger; but the harmful effect of the isolated and identified moulds such as *Aspergillus flavus*, *Aspergillus niger*, *Penicillium* spp. and *Rhizopus* spp. has to be taken into account when practicing hygiene rules in the production and preservation process of dried yam chips. The latter showed an infection of tubers by fungi and bacteria of the *Serratia* type. This study shows that yam chips in general represent a microbiological risk for consumers. The chips contamination shows that they provide the conditions for survival and Development for germs responsible for alteration and reduced sensory quality such as mold and germs that cause alteration of the sanitary quality (pathogens or toxin-producing).

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