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A Research Note

Survey of the Microbial Quality of Dry Fish, Cassava and Okra in Ghana

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ABSTRACT

A microbial profile of dry foods in Ghana including smoke dried herrings, salt dried tilapia, salt dried trigger fish, gari, kokonte and okra was evaluated. Okra had the highest aerobic count of 42 x 10^6, followed by kokone 16-20 x 10^4, smoke dried herrings 0.2-4 x 10^4, salt dried tilapia 3-4 x 10^4, salt dried trigger fish 3-44 x 10^2 and gari 3-34 x 10^2. Anaerobic count was low for all the samples except smoke dried herrings 7-9.5 x 10^2. Differences in mold count was not evident ranging from 2 x 10^2 to 39 x 10^3 for all samples. *Aspergillus* and *Penicillium* were the predominant molds. Coliform count was low for salt dried fish and gari, but higher for smoke dried herrings 2-25 x 10^2, kokonte 11-29 x 10^2 and okra 31-47 x 10^2.

Ghana, a tropical country in West Africa, lies on the Gulf of Guinea. Foods are sufficient during the rainy season but sometimes, food shortages are experienced during the dry season because of lack of adequate means of preserving food *(4)*. Only a small variety of foods grown or produced are processed. The most common method of preserving food is sun drying. Fish, an important source of animal protein, is preserved either by smoke drying, sun drying, salting or a combination of these methods *(6,7)*. Smoke dried herrings, salted tilapia, trigger fish, oyster and shrimps are dried seafoods commonly seen in the market. Cassava, the major staple in West Africa, is a perishable crop which is commonly processed into two products: gari and kokonte. Gari is made by peeling cassava followed by grating, fermenting and drying while kokonte is made by peeling cassava, sun drying and grinding it into flour *(5)*. Okra, a common vegetable in Ghana, is sometimes dried and used in soup. There is no large food industry, and processing of these dried products does not take place in villages. The microbiological quality of these products has not been thoroughly studied. Limited data are available on the microbial quality of dry foods sold in the market in Ghana. The present work was therefore conducted to survey and evaluate the microbial quality of dried fish, cassava and okra which are commonly consumed in Ghana.

MATERIALS AND METHODS

Sample Collection

Three types of fish, smoke dried herrings (*Sardinella* spp. which is called "Herrings" in Ghana), salt dried trigger fish and salt dried tilapia; two cassava products, gari and kokonte, and dry okra, were collected and microbial quality determined.

One hundred kg each of freshly caught herrings, trigger fish and tilapia were purchased at Elmina and Chorkor, two fishing villages in Ghana. Herrings were smoke dried while trigger fish and tilapia were salted, then sun dried. Arrangements were made with villagers to process these batches along with their regular quantities and store them under the same local conditions. Similar procedures were used to procure other food samples. About 20 kg each of freshly prepared gari and kokonte were purchased from cassava processors at Ada, one of the major cassava production regions in Ghana. Gari and kokonte samples were stored under local villages conditions at Ada for 4 1/2 months. Five kg of okra were sun-dried then stored at the Food Research Institute, Accra, at room temperature for 6 months.

Sampling was performed by scientists at the Food Research Institute, Aceraa at 3 and 6 month intervals for salt dried trigger fish, tilapia and smoke dried herrings. Gari, kokonte and okra were sampled at 3 and 4 1/2 months. Pre-sterilized sampling bags (Fisher Scientific, Norcross, GA) were used for sample storage. Quadruplicate samples were collected for each food item. The samples were shipped immediately to the Food Science and Nutrition Laboratory, Tuskegee University, Tuskegee, Alabama by air (about 20 h flight time at 20-25°C) for analysis.

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Sample Preparation

One g sample weighed under aseptic conditions was added to 99 ml dilution buffer (pH 7, 0.05 M phosphate) and serial dilutions were made. Duplicate analysis was made for each sample and each dilution consisted of two plates. Analyses were repeated with some samples until consistent results were obtained. Diluted samples were pipetted into petri-dishes, Difco plate agar medium poured in the petri-dish and mixed thoroughly with sample solutions for aerobic plate counts (*1*). The plates were incubated at 30°C for three d. Anaerobic plate counts were made by incubating the plates in an anaerobic jar for three d at 30°C. Gas-Pak (BBL product, Cockysville, MD) was employed to create anaerobic conditions. For molds, Difco's potato dextrose agar was employed. The agar medium was acidified to pH 3.5 with 10% citric acid. The plates were incubated at room temperature for 4 d. Difco's violet red bile agar was used to count coliforms. An overlay was employed. The plates were incubated at 35-37°C for 24 h. A Quebec colony counter was employed to count the number of colonies in the plates. Results were expressed as the number of microorganisms per g sample. Identification of molds was made by microscopic observation.

RESULTS AND DISCUSSION

The results of microbial analysis are summarized and shown in Table 1. Comparison of dry fish products indicated that the microbial counts were greater for smoke dry herrings than for salt dried tilapia and trigger fish. The smoke dried herrings were positive to both anaerobic and coliform counts whereas salt dried tilapia had low anaerobic count and salt dried trigger fish had low coliform count. It appears that microbial counts are generally low in salted dried fish. The use of salt at high concentrations and dehydration might have prevented the growth of anaerobes and coliforms. Anaerobic plate count may include anaerobes as well as facultative anaerobes such as lactic acid bacteria and *Escherichia coli*. The effect of storage time on microbial counts of dry fish were not clear. Only aerobic counts of smoke dried herrings decreased after storage of six months.

Microbial counts of cassava products especially that of gari were low. Both anaerobic and coliform counts were lower than that of kokonte. The development of acidity as a result of fermentation might have discouraged the growth of anaerobes and coliforms. Gari samples analyzed in this study appeared to have a low microbial population. The microbial counts were slightly greater for kokonte when compared to gari. The kokonte samples were also positive to coliforms. The effect of storage time was not clear. The storage time difference between three and four and a half months may not be long enough to exhibit significant difference among kokonte and gari samples.

Among the samples analyzed in this study, okra had the highest number of microorganism indicating a poor microbial quality of this product. The reason may be that okra contains high levels of pectin and other polysaccharides that make it viscous, sticky and hard to dry. Okra which is exposed to the environment might become highly

TABLE 1. *Microbial counts[1] of foods from Ghana.*

Sample	Storage[2] month		Aerobic count	Anaerobic count	Mold count	Coliform count
Smoked herrings	3	Range	$2\text{-}10 \times 10^4$	$0\text{-}26 \times 10^2$	$1\text{-}63 \times 10^2$	$0\text{-}90 \times 10^2$
		Mean	4×10^4	9×10^2	16×10^2	25×10^2
	6	Range	$2\text{-}60 \times 10^2$	$0\text{-}25 \times 10^2$	$1\text{-}52 \times 10^2$	$1\text{-}6 \times 10^2$
		Mean	22×10^2	7×10^2	15×10^2	2×10^2
Salted dry trigger fish	3	Range	$10\text{-}59 \times 10^2$	$<10^2$	$2\text{-}66 \times 10^2$	$<10^2$
		Mean	3×10^2	$<10^2$	28×10^2	$<10^2$
	6	Range	$30\text{-}59 \times 10^2$	$0\text{-}1 \times 10^2$	$2\text{-}56 \times 10^2$	$<10^2$
		Mean	44×10^2	$0\text{-}5 \times 10^2$	22×10^2	$<10^2$
Salted dry tilapia	3	Range	$22\text{-}37 \times 10^2$	$<10^2$	$1\text{-}3 \times 10^2$	$0\text{-}1 \times 10^2$
		Mean	30×10^2	$<10^2$	2×10^2	0.5×10^2
	6	Range	$20\text{-}98 \times 10^2$	$<10^2$	$1\text{-}2 \times 10^2$	$0\text{-}1 \times 10^2$
		Mean	44×10^2	$<10^2$	1.5×10^2	0.5×10^2
Gari	3	Range	$2\text{-}8 \times 10^3$	$<10^2$	$1\text{-}8 \times 10^2$	$<10^2$
		Mean	3.4×10^3	$<10^2$	4×10^2	$<10^2$
	4	Range	$2\text{-}5 \times 10^2$	$0\text{-}2 \times 10^2$	$0\text{-}2 \times 10^2$	$<10^2$
		Mean	3×10^2	1×10^2	$0\text{-}5 \times 10^2$	$<10^2$
Kokonte	3	Range	$12\text{-}30 \times 10^4$	$<10^2$	$2\text{-}10 \times 10^3$	$4\text{-}22 \times 10^2$
		Mean	16×10^4	$<10^2$	6.5×10^3	11×10^2
	4	Range	$13\text{-}25 \times 10^4$	$<10^2$	$6\text{-}22 \times 10^2$	$10\text{-}69 \times 10^2$
		Mean	20×10^4	$<10^2$	11×10^2	29×10^2
Okra	3	Range	$36\text{-}55 \times 10^6$	$<10^2$	$32\text{-}53 \times 10^2$	$40\text{-}55 \times 10^2$
		Mean	41×10^6	$<10^2$	39×10^2	47×10^2
	6	Range	$36\text{-}52 \times 10^6$	$<10^2$	$30\text{-}56 \times 10^3$	$22\text{-}47 \times 10^2$
		Mean	42×10^6	$<10^2$	39×10^3	31×10^2

[1] No. of organism/g sample.
[2] Time of storage under local condition at processor's place.

contaminated because of the longer drying time required. Coliform count is used to determine lactose fermentating bacteria such as *E. coli* and *Enterobacter aerogenes*. It is not clear why kokonte and okra had a relatively high coliform count while their anaerobic plate count was low. It may be that the samples analyzed contained larger numbers of other lactose fermenting bacteria which do not grow well under anaerobic conditions.

In order to reduce the microbial load, drying conditions should be improved. Higher temperatures or better ventilation may reduce drying time. Use of screens during drying to prevent insects such as flies from gathering on okra may also prevent contamination.

In this study only mold colonies were counted because few yeast colonies were found in all the samples analyzed. predominant types of molds were *Aspergillus* and *Penicillium* species. Generally mold counts were not high for cassava and fish products. They did not show any definite correlation with location and storage time for all the samples analyzed. The reason may be that foods prepared at villages are not aseptically packaged. They are usually kept in baskets, tin cans or in paper bags loosely covered with tree leaves or newspaper and stored under an open environment, therefore foods are unprotected from mold spores in the air.

Smoke dried herrings are one of the most popular food items in Ghana. The results of our preliminary study showed that it had relatively high levels of anaerobic and coliform counts. Further study is needed to determine the presence of *Clostridium botulinum* type E and other pathogenic bacteria. The former is often implicated in the outbreak of botulism in seafoods *(2,3)*. In order to improve microbial quality of smoke dried herrings, methods of handling of fish, smoke drying temperature and time, as well as storage condition of herrings need to be investigated.

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McAllister et al., *con't. from p. 659*

DISCUSSION

The preceding data support the applicability of Petrifilm methods for microbial monitoring in poultry processing facilities.

Petrifilm methods were tested side by side with conventional plating methods in a poultry processing plant using actual samples during the processing operation. Methods included swabs of carcasses and rinsing of pieces. No difference was seen between the Petrifilm and conventional methods for enumeration of total bacterial populations. Although there was little coliform contamination, no trends were seen in the ability of either method to detect coliforms that were present. These were naturally contaminated samples.

Much of the microbial monitoring is done on "finished" poultry products, i.e., those that have been further processed and have been breaded, precooked, and/or frozen. Because these products have been processed, they have very low levels of microbial contamination and we were unable to obtain naturally contaminated samples. In order to demonstrate that Petrifilm methods would detect microorganisms on these samples, if they were present, we demonstrated the efficiency of recovery of a variety of microorganisms that might be found as natural contaminants. A pseudomonas was tested as an example of a gram negative spoilage organism; staphylococcus was an example of a gram positive organism that could pose a safety hazard. Hafnia and an enterobacter were two examples of non fecal-coliforms. Organisms were inoculated into the chicken products at different levels, and held overnight in the refrigerator to simulate the stress the organism would see in the food product. There was no difference in efficiency of recovery of these organisms by either Petrifilm or conventional methods.

The ease of use, performance and versatility of the Petrifilm method makes it an attractive alternative for monitoring microbial levels in poultry processing facilities.

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