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MAIZE PROCESSING IN GHANA: A REPORT ON KENKEY PRODUCTION

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SUMMARY

A study covering 75 maize processors in five agro-ecological zones of Ghana was conducted to study the traditional maize processing industry in Ghana with special emphasis on the unit operations involved in the production of kenkey. The study established that kenkey production is an activity dominated by women, most of them with elementary or no formal education. Maize for processing was usually purchased from middlemen in the local markets in the areas where processing was carried out with majority of processors showing a preference for the local varieties of maize over the newly developed cultivars due to a claimed better swelling capacity of the local varieties. Maize was purchased and stored in kitchens, living rooms and on verandahs for periods of time ranging up to six weeks. A wide variation in the scale of kenkey production was evident with the majority processing between 2 and 20 kg of maize.

The study showed that most processors followed the traditional method of kenkey production involving the stages of cleaning, steeping, milling, doughing, fermentation, aflata preparation, mixing and moulding into balls, wrapping and cooking. Distinct variations in steeping and fermentation times were however observed for the various zones. Most processors in the Coastal Scrub zone steeped maize for one or two days and fermented the resulting maize dough for 3 days whilst majority of processors from the other zones steeped maize for a period of 3 days and fermented the dough for one day. A few processors omitted the aflata preparation stage due to the labour intensive nature of that stage. The cooking time for kenkey varied from one to four hours. The major constraints facing kenkey processors were problems related to the heat generated by fires used during the aflata preparation and kenkey boiling stages. Financial and marketing problems were also named by some of the processors.

1 INTRODUCTION

Maize (*Zea mays*) is a dietary staple in Ghana as well as in other West African countries and is currently the most widely cultivated cereal crop in the country with a total annual production of 1.014 million metric tonnes (FAO, 2001). A large proportion of the maize produced in Ghana is consumed in the fermented form through traditional spontaneous and uncontrolled fermentations. The fermented dough is used to prepare several foods such as snacks, staples and beverages. It is known that maize can enter into all three meals of the day without any monotony (Dovlo, 1970). The most popular maize foods in Ghana are 'kenkey', 'koko' and 'banku'. There are two main types of 'kenkey', the 'Ga kenkey' locally referred to as 'Komi' and 'Fanti kenkey' (Dokon). Both types of 'kenkey' can be described as cooked sour-tasting solid porridges of elastic consistency with a pH of about 3.7 (Halm et al., 1993). It is usually eaten with fish and sauce.

'Koko' also known as 'akasa' is made from fermented maize dough. It is a thin porridge sometimes eaten for breakfast by adults and is the traditional weaning food for Ghanaian babies. 'Banku' is similar to kenkey but has a semi-solid consistency. During the cooking of 'banku', the fermented dough is mixed with water and stirred till cooked. It is normally eaten with sauce. 'Akple' is similar to 'banku' except that fermented maize dough is mixed with fermented cassava dough before cooking. Other products made from maize include 'abolo' (a solid cake-like product made from dehulled maize with a fluffy consistency) and 'fomfom' (a stiff porridge similar to kenkey in consistency and also from dehulled maize).

Traditionally, the preparation of 'kenkey' involves several steps including aflata preparation (aflatalization) which leads to the attainment of a characteristic texture (Bediako-Amoa and Austin, 1976; Sefa-Dedeh, 1993). It is however not known if variations exist in the preparation of 'kenkey' within the various agro-ecological zones of Ghana.

Maize grain is often harvested at a moisture content which is conducive for the growth, colonisation and mycotoxin production by a wide range of fungi. Mycological studies of Ghanaian maize kernels have showed the dominating mould genera to be *Aspergillus*, *Penicillium* and *Fusarium* (Jespersen et al., 1994). Further studies (Kpodo et al., 1996a), have demonstrated the presence of mycotoxins such as aflatoxins produced by *Aspergillus flavus* and *Aspergillus parasiticus* and citrinin produced by *Penicillium citrinum* on Ghanaian maize kernels and fermented maize products. It is also known that mycotoxin production can occur at any point in the food chain provided conditions are conducive.

The purpose of this study therefore, is to identify and document the unit operations associated with the processing of maize into Ga Kenkey and variations in processing techniques if any within the various agro-ecological zones of the country. This study further seeks to identify if possible unit operations which could favour the growth of moulds and ultimate mycotoxin production

2 MATERIALS AND METHODS

2.1 Selection of agro-ecological zones and maize processing sites

The major agro-ecological zones in Ghana based on vegetation and rainfall were selected for this study. These were the Coastal Scrub with less than 1000 mm of rainfall per year and described as very dry; the Guinea Savannah zone with an annual rainfall between 1000 and 1250 mm, described as dry; the Transitional zone with rainfall between 1250 and 1500 mm of rain (medium); the Tropical Forest with an annual rainfall between 1500 and 2000 mm. (wet); and the Tropical Rain Forest zone with an annual rainfall of more than 2000 mm and described as very wet.

One major city or town was identified and selected in each agro-ecological zone. The selected cities were Accra in the Greater Accra region representing the Coastal Scrub, Tamale in the Northern region for the Guinea Savannah zone, Wenchi in the Brong-Ahafo region for the Transitional zone, Kumasi in the Ashanti region for the Tropical Forest zone. The town of Mpatamba in the Western region was selected to represent the Tropical Rain Forest zone. The help of officials of the Extension Division and the Women in Agriculture Development (WIAD) Division of the Ministry of Food and Agriculture in each of the regions was solicited and fifteen major maize processing sites were randomly chosen in each selected city or town. The sites were selected on the basis that they were large, commercial maize processing sites. All the samples were obtained during the dry season between January and June 1999.

Accra is the capital city of Ghana with a population of over 2 million. Though kenkey is produced and consumed throughout Ghana, Accra could be said to have the highest concentration of producers and consumers. For the purposes of this study, Accra and its suburbs were divided into 14 localities. The localities were Teshie, La, Chorkor, Bukom, Adabraka, Achimota, Nima, Madina, Darkuman, Mamprobi, Korle Gonno, Kaneshie, Pig Farm and Osu. One processor was selected from each locality except Bukom where 2 processors were selected due to the relatively high concentration of maize processors.

2.2 Design of questionnaires

A questionnaire was designed and pre-tested at two processing sites in the Greater Accra region namely Osu and Bukom. The questionnaire was then used to collect background information about the processors, information about maize processed at their sites and processing techniques used in the production of kenkey. A copy of the questionnaire used is attached as Appendix 1. A total of 75 maize processors were interviewed in the study.

2.3 Analysis of questionnaire data

The statistical package used for the analysis of questionnaire data was the Statistical Package for Social Scientists (SPSS), (1993). Answers to "yes or no" answers were entered as binomial values. Answers to categorical questions were coded and entered as numbers for subsequent analysis.

3. RESULTS

3.1 Background information about processors

All the seventy-five respondents interviewed were females suggesting that processing of maize into kenkey is predominantly a female profession in Ghana. Majority (73%) of the respondents were aged between 31 and 60 years. Tables 1 and 2 show the distribution of the processors by age and the educational levels attained respectively.

Forty-five respondents (60%) had not had any formal education. Twenty-seven (36%) had completed elementary school whilst 3 (4%) had completed vocational school. Sixty-three processors (84%) produced only Ga kenkey whilst 7 (9.3%) produced only Fanti kenkey. Ga kenkey and banku were produced by 4 (5.3%) of the processors and one (1.3%) other processor produced both Ga kenkey and aflata for sale. All the 7 producers of Fanti kenkey were from the Tropical Rain Forest zone.

Table 1 Distribution of processors by age across agro-ecological zones

Age of processor (years)	CS[a]	TRF[b]	TF[c]	TS[d]	GS[e]	Total
20 – 30	0	5	3	1	1	10
31 – 40	3	5	3	5	7	23
41 – 50	4	1	5	2	2	14
51 – 60	3	2	3	6	3	17
61 – 70	2	2	0	1	2	7
Over 70	3	0	0	0	0	3
Refused to give age	0	0	1	0	0	1

CS[a] = Coastal Scrub
TRF[b] = Tropical Rain Forest
TF[c] = Tropical Forest
TS[d] = Transitional
GS[e] = Guinea Savannah

respondents, Wenchi (16%), Daboya (4%) and Sunyani (2%). Other towns and areas named were Aburi, Agogo, Akrobi, Apredarko, Asesewa, Bechem, Kintampo, Konongo, Tamale and Tepa.

When asked when the maize batch they were processing at the time of the interview was harvested, 19 (25.3%) of the 75 respondents did not know. This figure included all the respondents in the Tropical Rain-Forest zone. Two respondents each from the Coastal scrub and Guinea Savannah zones also could not indicate when the maize was harvested. The remaining 56 respondents gave varying answers as shown in Table 3. A total of 24 (32%) of the processors interviewed said the maize they were processing at the time of the interview was harvested less than 3 months ago. Thirteen (17.3%) said the maize was between 4 and 6 months old whilst 19 (25.3%) of the processors said their maize was between 7 and 9 months old.

Table 3 Processors responses concerning harvest time / age of maize (%)

Age of maize (months)	CS[a]	TRF[b]	TF[c]	TS[d]	GS[e]	Total
< 3	13.3	0.0	1.3	13.3	4.0	32.0
4 – 6	4.0	0.0	0.0	2.7	10.7	17.4
7 – 9	0.0	0.0	18.7	4.0	2.7	25.3
Do not know	2.7	20.0	0.0	0.0	2.7	25.3

CS[a] = Coastal Scrub
TRF[b] = Tropical Rain Forest
TF[c] = Tropical Forest
TS[d] = Transitional
GS[e] = Guinea Savannah

Table 2 Distribution of processors by educational level attained

Educational level attained	CS[a]	TRF[b]	TF[c]	TS[d]	GS[e]	Total
No formal education	9	11	8	11	6	45
Completed elementary school	6	4	6	4	7	27
Completed vocational school	0	0	1	0	2	3

CS[a] = Coastal Scrub
TRF[b] = Tropical Rain Forest
TF[c] = Tropical Forest
TS[d] = Transitional
GS[e] = Guinea Savannah

3.2 Maize history

Fifty-two (69.3%) of the 75 maize processors interviewed purchased their maize from middlemen in their local markets. Eleven of the 15 processors interviewed in the Coastal Scrub zone (Greater Accra region) however travelled to the major maize-growing areas such as Techiman in the Brong-Ahafo region, Asesewa in the Eastern region and Kumasi in the Ashanti region to purchase their supplies of maize. All the respondents in the Tropical Rain Forest zone purchased maize from middlemen in their local markets. In the Tropical Forest zone 12 of the 15 respondents used middlemen for their supply whilst 3 processors bought their maize from farmers in the area. In the Transitional zone which covers some of the major maize growing areas in the country, only 7 processors purchased their maize from middle-men in the local markets. The remaining 8 processors bought their maize directly from farmers in areas around Wenchi where the survey was conducted. All except one of the respondents in the Guinea Savannah zone purchased their maize from middlemen in one particular local market (Aboabo market). One respondent in this zone said she obtained her maize supply from a village close to Tamale. Seventeen (22.7%) of the 75 respondents did not know where the maize they purchased was grown. Others listed a variety of towns where the maize they used was grown. The most frequently named towns included Techiman which was named by 26 (34.7%)

Nearly 79% of respondents indicated that they preferred the local varieties of maize, which they often referred to as the "small type" to the improved types. Twelve (14.7%) said they did not have a preference with variety and that they purchased whichever type was available in the market. Nine of these respondents were from the Tropical Rain Forest zone. Five respondents said they preferred the improved varieties namely the "dobidi" and the "obatanpa". Apart from the Tropical Rain Forest zone the preference for the local maize variety cut across all the agro-ecological zones. All the processors in the Tropical Forest and Transitional zones said they preferred the local varieties. Fourteen of 15 processors in the Guinea Savannah zone and 12 of 15 in the Coastal Scrub zone also indicated their preference for the local varieties over the improved ones.

Several reasons were given for their preference. Fifty-one of the 59 processors who preferred the local variety of maize said their preference was because these varieties produced more dough during processing and thereby the profit margins. Furthermore, 4 and 3 processors respectively listed "good taste" and "good texture" as additional reasons why they preferred the local varieties. Reasons given by the remaining processors who indicated a preference for the local varieties were that they were of a good quality and not easily infested by insects. Respondents who preferred the improved maize varieties said they were of good quality and relatively resistant to insect attack and also produced kenkey with good taste.

The amount of maize purchased at a time varied considerably. The lowest amount purchased was 10 kg and the highest amount recorded was 2000 kg. The amounts of maize purchased at a time by processors in the various agro-ecological zones is given in Table 4. Majority (82.7%) of processors however purchased between 100 kg (1 bag) and 500 kg (5 bags) at a time. Seven processors (9.3%) purchased between 600 kg and 2000 kg. The remaining processors (8.0%) purchased between 10 kg and 60 kg of maize at a time. All processors in the Coastal Scrub and the Tropical Rain Forest zones purchased more than 100 kg of maize at a time. One processor from the Guinea Savannah zone, two from the Tropical Forest and three from the Transitional zones respectively purchased less than a 100 kg of maize at a time. Six respondents from the Coastal Scrub zone purchased over 500 kg of maize at a time as compared to one respondent from the Tropical Forest zone. No respondents from the Tropical Rain Forest, Transitional and Guinea Savannah zones purchased more than 500 kg of maize at a time.

Table 4 **Distribution of respondents by amount of maize purchased at a time by agro-ecological zones**

Amount of maize (kg)	CS[a]	TRF[b]	TF[c]	TS[d]	GS[e]	Total
< 100	0	0	2	3	1	6
100 – 500	9	15	12	12	14	62
> 500	6	0	1	0	0	7

CS[a] = Coastal Scrub
TRF[b] = Tropical Rain Forest
TF[c] = Tropical Forest
TS[d] = Transitional
GS[e] = Guinea Savannah

Seventy-two (96%) of the 75 respondents purchased maize packaged in jute sacks. One respondent from the Coastal Scrub zone purchased her maize packaged in polyethylene bags whilst two respondents from the Transitional zone purchased maize retailed from aluminium bowls. The frequency of purchasing maize varied considerably from once every four days to once every 4 months. Sixteen (21.3%) respondents purchased maize once every week, 24 (32%) every two weeks and 20 (26.7%) purchased maize once every month. One processor each from the Coastal Scrub and Tropical Forest zones purchased maize every six weeks. One respondent from Accra in the Coastal Scrub zone travelled to Techiman in the Brong-Ahafo region every six weeks to purchase 1000 kg (10 bags) of maize whilst another respondent from the same zone travelled to Asesewa in the Eastern region every four months to purchase 500kg.

Seventy-three (97.3%) out of the seventy-five respondents purchased and stored maize for subsequent processing. One respondent each from the Transitional and Guinea Savannah zones did not store their maize. Each of the two respondents purchased 10 kg of maize three times a week and once weekly respectively. Several places were named by respondents as storage rooms for the maize purchased. These included kitchen, named by 22 (29.3%) respondents, verandah (21.3%), storeroom (21.3%), living room (20%). One respondent each stored maize in the following places: room where maize is milled, wooden kiosk, on a platform, and in a drum. The length of storage time tended to coincide with the frequency with which maize was purchased for all the processors interviewed.

3.3 Frequency of processing

The frequency of processing maize into kenkey varied from processor to processor. Sixty-five (86.7%) of the seventy-five respondents processed maize into kenkey six days a week. Processing was not carried out on either Saturday or Sunday. All respondents in the Coastal Scrub and Guinea Savannah zones processed maize six days in a week. In the Tropical Forest and Transitional zones, all except two and one processor respectively processed maize six days in a week. They processed maize three days in a week. In the Tropical Rain Forest zone where seven of the 15 processors interviewed produced Fanti kenkey, only nine respondents processed maize six days in a week. One respondent said she processed maize five days in a week, three respondents processed maize two days in the week and another two, two days in a week.

The amount of maize processed into kenkey at a time varied from as low as 2 kg to 150 kg. Majority (82.7%) of the 75 respondents however processed between 2 and 20 kg of maize at a time. Table 5 shows the distribution of processors according to the amount of maize processed at a time for each agro-ecological zone. Most processors in the Coastal Scrub processed more than 10 kg of maize at a time. The trend was different in the other zones where most processors processed between 2 and 10 kg at a time. Only five (6.7%) respondents processed over 40 kg of maize at a time and these processors were all from the Coastal Scrub zone.

3.4 Cleaning of maize

When asked if they cleaned maize kernels before processing, over 97% of the respondents answered in the affirmative. Only two processors said they did not clean maize kernels before processing. However, when asked how they cleaned the maize kernels five of the 73 respondents were unable to answer. The remaining 68 respondents gave a variety of responses as to how they cleaned the kernels. These were sieving maize kernels with a basket, washing kernels with water, a combination of sieving and washing with water and finally, by soaking kernels in water for a few minutes, stirring and decanting off the chaff and other floating materials. The frequency of use of these methods across agro-ecological zones is shown in Table 6.

Most processors in the Coastal Scrub and the Tropical Rain Forest zones employed sieving and subsequent washing with water to clean their maize kernels before processing whilst majority of processors from the Transitional and Guinea Savannah zones used the soaking in water, stirring and decanting method. In the Tropical Forest zone however, both

methods were used by the processors interviewed. Two respondents from the Coastal Scrub zone said their cleaning methods involved only sieving using raffia baskets. As to why they cleaned maize before processing, 28 respondents said they did so to obtain good quality dough and kenkey, 22 respondents simply said to remove stones and other unwanted materials from the maize kernels before processing, 8 respondents said to remove weevils and dirt. The remaining five respondents to this question said they cleaned kernels to obtain products with a good colour.

Table 5 Distribution of processors according to amount of maize processed at a time

Amount of maize processed	CS[a]	TRF[b]	TF[c]	TS[d]	GS[e]	Total
2 – 10 kg	1	10	10	7	6	34
11 – 20 kg	9	4	3	5	7	28
Over 20 kg	5	1	2	3	2	13

CS[a] = Coastal Scrub
TRF[b] = Tropical Rain Forest
TF[c] = Tropical Forest
TS[d] = Transitional
GS[e] = Guinea Savannah

Table 6 Distribution of processors according to methods used in cleaning maize kernels

Cleaning method	CS[a]	TRF[b]	TF[c]	TS[d]	GS[e]	Total
Washing with water	0	1	0	0	0	1
Sieving with basket	2	0	0	0	0	2
Sieving and washing with water	6	13	8	1	2	30
Soaking in water, stirring and decanting	0	1	7	14	13	35

CS[a] = Coastal Scrub
TRF[b] = Tropical Rain Forest
TF[c] = Tropical Forest
TS[d] = Transitional
GS[e] = Guinea Savannah

3.5 Steeping and milling

Majority (76%) of the 75 processors interviewed steeped maize for 3 days. It was observed that 56 of the 60 respondents from the Tropical Rain Forest, Tropical Forest, Transitional and Guinea Savannah zones steeped their maize for 3 days. In The Coastal Scrub zone however, there were variations in the steeping time for maize. Nine of the 15 respondents steeped maize for 2 days whilst 5 steeped for only a day. Only one respondent from this zone steeped her maize for 3 days. Forty-six of the 57 respondents who steeped maize for 3 days preferred this length of time because according to them the maize kernels were easier to mill. The remaining 11 respondents said maize steeped for three days gave a better product in terms of texture. Most processors who steeped maize for two days said they did so because if steeped for more than 2 days the kernels acquired an unpleasant smell. Incidentally, this same reason was stated by those processors who steeped their kernels for just a day before milling as well. The remainder of these processors who steeped maize for 2 days said they did so to avoid the milled kernels sticking in the milling machine.

Three main types of containers were identified for steeping maize. These were the aluminium bowl or drum used by 30 (40%) of the respondents, the plastic drum used by 25 (33.3%) and the cast-iron pot which was used by 19 (25:3%) of the respondents. The use of these containers cut across all the agro-ecological zones. However, one respondent in the Guinea Savannah zone used an earthenware pot for steeping her maize kernels. All the 75 respondents used disc attrition mills installed in their various localities to mill their steeped maize.

3.6 Fermentation and cooking

Containers used for fermenting maize dough were similar to those used for steeping maize. Forty-seven (62.7%) of the seventy-five respondents said they used aluminium bowls or drums, 18 (24%) used plastic drums and 8 (10.7%) of the respondents said they used cast iron pots for fermentation. One processor in the Coastal Scrub zone placed the dough packed in polyethylene bags into baskets to ferment whilst one other processor from the same zone, packed her dough into wooden troughs to ferment.

There was a distinct variation in fermentation time between the Coastal Scrub zone and the other four zones. Fifty-seven (95%) of the 60 respondents from Tropical Rain Forest, Forest, Transitional and Guinea Savannah zones fermented their maize dough for just a day. Of the remaining three respondents from these zones, two respondents from the Guinea Savannah zone said they fermented maize dough for two days whilst only one processor from

the Tropical Rain Forest zone fermented her dough for 3 days. In the Coastal Scrub zone however, twelve of the fifteen respondents fermented maize dough for three days. Two fermented for two days and only one processor from this zone fermented maize dough for one day. It is worth noting however that as indicated earlier whilst most processors from all the other zones steeped maize for 3 days, majority of the processors from the Coastal Scrub zone steeped maize for just 1 or 2 days.

In answer to the question why fermentation was carried out for the period of time indicated by the respondents, it became clear that most processors (31 of 59) in the Tropical Rain Forest, Forest, Transitional, and Guinea Savannah zones preferred kenkey with a less acidic taste and that was the reason why they fermented the dough for just a day. Other reasons given were that kenkey developed an unpleasant smell if dough was left to ferment for a period exceeding two days and that kenkey was of a better quality when dough was fermented for just a day. Processors who fermented maize dough for periods of 2 and 3 days said they did so to get a good quality product and also to soften the milled kernels to get kenkey with a better texture.

Contrary to earlier belief, not all kenkey processors prepare aflata (thick paste cooked from fermented dough by continuously stirring a portion of the dough mixed with water). It was revealed that of the 75 respondents, eleven (14.7%) did not prepare aflata. Five processors from the Tropical Forest zone and six from the Transitional zone half-cooked all the fermented dough, moulded it into balls, wrapped them in corn husks, before cooking into kenkey. All the respondents however packaged their moulded "dough" before cooking although the packaging material differed depending on the type of kenkey being produced. All producers of Ga kenkey packaged their product in maize husks while the seven producers of Fanti kenkey in the Tropical Rain Forest zone packaged their product in dried plantain leaves.

There was much variation in the cooking time for kenkey across agro-ecological zones. All the 15 respondents from the Coastal Scrub zone cooked their kenkey for a minimum time of three hours. Twelve of the fifteen processors in this zone used a three-hour cooking time, two cooked their kenkey for three and a half hours whilst one processor cooked the product for four hours. Most of the processors from the other four zones cooked kenkey for two hours. Considering all the 75 respondents, 36 (48%) cooked their kenkey for two hours, 16 (21.3%) used three hours whilst 12 (16%) cooked for just one hour. The cooking time may however be said to be dependent on several parameters such as the scale of production, the type of cooking vessel and the source of heat. The scale of production in the Coastal Scrub zone is known to be relatively high and it is likely much larger cooking vessels are used to cook the

product and this will require longer cooking times than when smaller vessels are used. Sixty-five (86.7%) of the 75 respondents said they sold all their product within one day. Seven (9.3%) respondents (three from the Coastal Scrub zone and four from the Guinea Savannah zone), all producers of Ga kenkey said they sometimes had left-overs which they sold by the end of the second day. Three respondents in the Tropical Rain Forest zone who produced Fanti kenkey which has a longer life span than Ga kenkey usually sold all their product within three days.

3.7 Problems encountered during processing

When respondents were asked about the problems they encountered in their work, thirty (40%) said they did not have any problems, 24 (32%) said they had problems with the heat generated from the fires used in aflata preparation and cooking of the product. Nine (12%) of the respondents said they had financial problems and needed more capital to run the business due to the high cost of raw materials. Seven (9.3%) processors said the process of kenkey manufacturing was very labour intensive and complained of fatigue and the remaining five (6.7%) respondents said they had problems marketing their product.

4. DISCUSSION

It was revealed from the survey that the origin of maize processed at the various sites could not be determined as most processors purchased maize from middlemen in their local markets. A few large-scale processors actually travelled to the markets in the major maize growing areas to purchase their supplies. Mycotoxin or specifically aflatoxin levels are not checked by the farmers nor the processors and it is likely mycotoxins would have been formed in the maize from the farm before purchase by the middlemen from the different zones. A grading system for maize should be introduced in addition to a rapid screening method to enable farmers and processors ascertain the levels of aflatoxins present in the consignments they intend to purchase.

From the study, only 21% of the processors stored their maize in a storeroom. Others used their verandahs, kitchen, and living rooms for storage. Storage on verandahs especially if not enclosed could expose maize to the vagaries of the weather including rain which may result in increased moisture contents, mould growth with possible mycotoxin production.

Maize provides significant amounts of the daily intake of calories and proteins as well as other nutrients in several African countries including Ghana (Bressani, 1991). Maize like

most cereals are known to be relatively low in protein content and in addition have limited amounts of one or two essential amino acids such as lysine and tryptophan (Bressani et al., 1968). Furthermore, the other food components of diets in several maize consuming countries fail to provide the needed nutrients particularly protein quality to offset the nutritional deficiencies of maize. In an effort to curb this problem in Ghana, several high quality protein maize varieties have been developed and released unto the Ghanaian market (Twumasi-Afriyie et al., 1991)

The current study revealed that almost 80% of the respondents preferred the local varieties of maize to the newly developed cultivars. The popular reason given being that the local varieties produce more dough and thereby their profit margins. One is tempted to think that their preference has more to do with financial gain rather than the sensory and physico-chemical characteristics of the end product. The production of more dough by the local varieties as claimed may be due to the fact that the kernels of the local varieties are relatively smaller than those of the new varieties (Plahar et al., 1987). Obiri-Danso et al. (1997) in their studies on the suitability of "Obatanpa" a high quality protein maize for kenkey production showed that it compared very well with "Okomasa", the local variety in its utilization for kenkey.

Maize screenings have been found to contain ten times the level of fumonisins found in whole kernel maize (Bennett et al., 1996) whilst studies by Kpodo et al. (1996b) have shown that aflatoxins are concentrated in the germs, screenings and hulls of maize kernels. The practice whereby most processors in the Tropical Rain Forest, Tropical Forest and the Coastal Scrub zones sieve maize kernels with a basket before washing in water should be encouraged as this practice will reduce both the fumonisins and aflatoxin contents of the maize kernels. Processors in the other zones such as the Transitional and Guinea Savannah zones should be taught and encouraged to adopt this practice.

The preparation of aflata (Aflatalization) is reported to be critical for the development of texture in the finished product in that it acts as a binding agent to give kenkey its firm and semi-sticky consistency (Sefa-Dedeh, 1993). This study showed that 14.7% of the respondents did not prepare aflata but rather half-cooked all the dough, moulded it into balls, wrapped the balls in corn husks and cooked. Most of the processors interviewed complained about the heat generated by the fires especially during the preparation of aflata and this may be the reason for some processors avoiding this stage.

5. CONCLUSIONS AND RECOMMENDATIONS

The major unit operations for the production of Kenkey have been confirmed as cleaning, steeping, milling, doughing, fermentation, aflata preparation, mixing and moulding, wrapping and boiling. Only slight variations in these operations were identified in some agro-ecological zones. It is recommended that maize should be stored in enclosed areas to prevent wetting by rain and sieving of maize to remove screenings should be encouraged to reduce aflatoxin contamination.

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7. APPENDIX

SURVEY QUESTIONNAIRE

STUDIES ON MAIZE UTILIZATION IN VARIOUS AGRO-ECOLOGICAL ZONES OF GHANA

1. Background Information

Name ..... Age..... Sex.....

Agro-ecological zone..... City/Area.....

Educational Level	Did you complete ?	
	Yes	No
None.....	.....	.....
Elementary.....	.....	.....
Technical/Vocational.....	.....	.....
Secondary.....	.....	.....
University.....	.....	.....

What products do you make from maize? .....

.....

.....

.....

2. Maize History

Where do you buy your maize from ? .....

Where is the maize grown ? .....

When was this batch of maize harvested ? .....

What type/variety of maize do you buy ? .....

Why?.....
.....

What quantity of maize do you buy at a time ? .....

How is maize packaged before purchasing ? .....

How often do you buy maize ? .....

Where do you store maize ? .....

How long do you keep maize in store ? .....

3. Maize Processing

How often do you process maize ? .....

What amount of maize do you process at a time ? .....

Do you clean maize kernels before processing ? .....

How do you clean maize before processing ? .....
.....
.....

Why do you clean maize before processing ? .....
.....

How long do you steep maize ? .....

Why ?
.....

What container do you use for steeping maize ? .....

Maize Processing (continued)

How do you mill maize ? .....

How long do you ferment maize ? .....

Why ? .....

What container do you use in fermenting maize ? .....

Do you prepare aflata ? .....

If no, how do you process maize after fermentation ? .....
.....

Do you package your fermented dough before cooking ? .....

If yes, what packaging material do you use ? .....

How long do you cook the maize product ? .....

How do you package your product for sale ? .....

How long does it take to sell one batch of your product ? .....

Do you have any problems with maize processing ? .....
.....
.....
.....
.....

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