SYMPOSIUM ON MAIZE

MAIZE FOR HUMANS

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World utilization of maize

In the developed countries, maize is often described as "the poor man's cereal" because it neither enters into the diet nor serve as a substitute for any of the recognized cereal staples such as wheat, oats or barley. In North America and Western Europe where wheat is consumed on a very large scale, maize if grown, serves mainly as feed for livestock and to a lesser extent as raw materials for industrial products such as starch and glucose.

Large-scale utilization of maize as human food therefore is more common in the poorer, less developed parts of the world, particularly the tropics where food production and farm yields are so low and uncertain as to put greater premium on the grains as items of food rather than as feed for animals or as raw materials for industry.

Nutritional aspects

As an item of diet, maize may be considered as one of the more nutritionally satisfying cereals in the tropics - perhaps just as satisfying as brown rice but on the whole, better than millet. For instance, maize is relatively more heavily-packed with protein quantitatively than any of the tropical grains and apparently has higher levels of Vitamin A precursor compounds. Its main draw-back, however, is in the quality of the protein - chiefly the essential amino acid (lysine and tryptophane) content. In these the crop is poorly deficient. We say these amino acids are essential because normally, they are not synthesized by the body or if they are, then at a rate not commensurate with normal physiological requirements. This means they are indispensable for life and must be provided for directly in the diet.

Along with the lack of tryptophane is the possibility that niacin, one of the members of the B-vitamin group may be bound to

other nutrients (e.g. carbohydrate) and hence be unavailable for metabolic processes. Because tryptophane is a precursor of niacin, the absence of which may result in pellagra (a rather unpleasant dry skin condition) this double deficiency augurs poorly for the nutritional status of maize, particularly among populations that subsist entirely on the produce wit out adequate supplementation from other (richer) dietary ~~sources~~ sources.

In Ghana, however, this sort of nutritional challenge is neither common, nor is it of known occurrence in the heavy maize-consuming areas particularly those of southern Ghana where traditional maize dishes as such/kenkey are supplemented to a large extent with fish. Besides local methods of preparing maize foods in which legumes, nuts and pulses are incorporated with the produce often lessens this prospect of deficiency, (Dovlo, 1970).

Consumer classes of maize

Maize in Ghana may be categorized into a number market classes on the basis of consumer and organoleptic requirements. These categories are more of commercial than taxanomic interest and must be viewed as such to avoid confusion with usual botanic classifications.

Thus, in terms of texture one may distinguish the hard, well-dried often more expensive grain called Kukudabi from the slightly cheaper, less-favoured, more moisture-laden variety known as Kpokploku. There is also a white and coloured (red, yellow) maize; the small kernel vs. the large kernel and the indigenous vs. the imported variety.

Ghanaian consumer preferences natura ly tend to favour the indigenous variety - particularly the hard, white small-grained Kukudabi. This is used in the preparation of the main maize staples - kenkey, banku and akple. Among the less-favoured varieties is yellow maize which includes an imported (American) variety used extensively in poultry-feeding in Ghana. The chief objection to yellow maize as an item of diet, stems of course, from its colour, as traditionally creamy and not yellow colours are preferred in maize dishes of all description.

Many poultry producers, our Food Research Institute surveys indicate, strongly prefer the yellow variety to the local white: they are particularly pleased with the returns - namely yellower yolk which is significant considering that carotene and vitamin A precursor compounds are sometimes deficient in poultry feeds in this country.

There are in fact, a great many poultry farmers in Ghana who feel that yellow maize supply lines should be kept open to serve as an outlet primarily for poultry feeding while conserving the white varieties for human use.

Maize as a staple food in Ghana

Though at one time maize was the chief staple food for the inhabitants of the coastal parts of Ghana, its utilization has today spread to all parts of the country. To be specific, maize has now become a 'convenience' dish in the form of kenkey or banku for all classes of people. The demand for kenkey as a food item is so strong that any uneasiness in supplies of maize is quickly and adversely registered in the size of the kenkey ball. Typically the balls get smaller while prices remain the same! This difficulty is further accentuated by the fact that maize has no substitute as a dietary item - comparable to fufu which occurs in a wide range of varieties e.g. as cassava, yam and plantain fufu. It is quite evident therefore that every effort will have to be made to increase the local production both on a long term and short term basis to meet the national demand at all times.

Value of maize as food

Local methods of preparing the baisc maize dishes theoretically help to conserve their value as food. In the first place, these processes involve milling or grinding of the whole grain - which has the advantage of 'concentrating' all the vitality and nutrients of this foodstuff into a single meal. When this meal is fermented it adds further to the value of the product in the variety of nutrients formed by microorganisms in the fermentative process.

Put another way, the simple milling or grinding of the conditioned maize - without sieving or refining ensures that the meal obtained shall include all parts of the entire grain while the fermentative action of the microorganisms in addition to improving the vitamin as well as amino acid levels increases the digestibility of the product. One unfortunate drawback, however, is that during cooking both kenkey and incidentally also banku tend to lose much of their riboflavin content - by about a third of the pre-possessing weight. (Ankrah, 1970). At the same time, it has been found that the cooking water of kenkey has correspondingly higher levels of riboflavin - obviously due to the leeching of this nutrient into the surrounding water during the cooking. The fact that "kenkey water" generally serves a drink in most kenkey producing-homes is significant from the nutritional point of view. The practice of drinking this liquid must therefore, be always encouraged.

Receptivity of maize in Ghana

The different market classes of maize in Ghana vary somewhat in their ability to make kenkey of acceptable quality - nutritional considerations aside. The question of receptivity therefore, is very important economically and socially, especially when thinking of introducing new varieties on the market or perhaps seeking a genetic improvement of existing varieties.

Recently at the Food Research Institute we embarked upon a series of studies and analyses of maize offered on the local market together with samples of kenkey prepared from them. The results indicated that the question of receptivity is a live one which cannot be ignored. To appreciate this study, it will be instructive to examine the characteristics of the ideal kenkey more closely.

Basically, an ideal kenkey must be of soft, smooth texture and pliable consistency. It should never be friable nor disintegrate into crumbs upon touch. This means it should not be dry. Above all, it must have a moderately sour taste and a creamy white colour. Ease of kernel conditioning prior to preparation is also

important, as is the degree of fermentation of the dough including its water-absorbing properties.

We began the study by securing two local and two exotic varieties of maize - both white in colour, to determine their response to the above traits. The exotic varieties were Diacol 153 and Composite II, both having been grown in Ghana and supplied by the Seed Multiplication Unit of the Ministry of Agriculture. The locals were Kukudabi and Kpokploku purchased on the open market.

Each of the grains were initially examined subjectively for appeal. Next portions were milled dry, to provide a bssis for a determination of their total bacterial and mould content in order to furnish some idea about their harvesting, storage and marketing conditions. Following this, weighed portions of the whole grain were soaked for nearly 48 hours to conditions the kernel then milled and prepared into kenkey. Other determinations included the proximate composition of the finished kenkey and consumer panel scores for such traits as consistency, sourness and creaminess. The results are presented in table 3.

Appearance characteristics generally turned out to be more desireable for the introduced grains than the locals. Obviously more properly-harvested and well-preserved or stored prior to distribution, the Diacol and Composite looked exceptionally clean and highly presentable. Besides they were whole and unbroken and contained less foreign matter and dirt in contrast to the locals. For instance, the bacterial count in the Diacol was less than 10 per gram compared with 20,000 for Kpokploku, while mould numbers were in excess of 500,000 per gram for Kukudabi but as low as 1,900 for Composite II. As is well known, traditional handling and marketing of foodstuffs in general are far from satisfactory and every effort must be made to pass experience gained under scientifically-controlled situations to the subsistence farmer.

In terms of processing characteristics, Kukudabi produced the best kenkey, both in quality, yield and several other respects. The water absorbing-capacity was as high as 100 % for Kukubadi which

augurs well for the economics of kenkey making. This means you get one extra ball of kenkey for every unit ball weight of maize dough you put in to the system. (Table 3D) Next in order of yield was Kpokploku, with 90%. Composite II and Diacol 153 by contrast scored slightly lower - 70 and 60 per cent respectively.

In spite of its high yield Kpokploku produced the worst kenkey physically and in terms of taste. For instance, the kernel conditioned extremely poorly while the texture of the kenkey was somewhat crumbly with a rather poor flavour reminiscent of weevil infestation.

Diacol and Composite kenkey were, by contrast, moderately good. Their weak points, however, were their low sourness and smoothness scores - the latter due mainly to the presence of flects of bran in the product. Also the introduced grains had a relatively higher fiber content than the local varieties. Some panelists thought the colour of the exotic grains was somewhat too whitish when creaminess was desired.

Despite these limitations it appears Diacol and Composite can still make a significant inroad into the food economy of Ghana. With modification of processing techniques, including the possibility of incorporating of mixtures of these varieties with acceptable locals like Kukudabi prior to preparation, a favourable beginning could, indeed be made.

Diversification of kenkey production

With the increased rate of urbanization and the employment of women outside the home it becomes necessary to seek even more convenient ways of making kenkey a convenience food. At the Food Research Institute, we are tackling the convenience foods problem on a broader scale - having produced lately an instant fufu mix. Currently we are working on the possibility of canning kenkey. All you need to do in the future then will be to open your can of kenkey, warm it and serve. Furthermore, we are thinking of developing an instant banku mix. The technical problems here (e.g. the need for a fermented taste) are enormous but it is the task of research to

seek solution to problems, and it is our hope we would succeed in coming up with answers before long.

I would not like to conclude this presentation with the impression that kenkey and related whole corn-dough dishes are the only foods prepared from maize in Ghana. Some 50-odd maize dishes have in fact been enumerated in Ghana including varieties prepared from the refined dough, the roasted meal and the unroasted meal and such special products as grit maize porridge and fermented beverages (Dovlo, 1970).

Recently our food consumption surveys and planning division concluded a study on the definition and identification of all 50 varieties of maize dishes - the results of which are expected to furnish a basis for the partial mechanization and development of processes for the eventual commercialization of the traditional methods of processing this foodstuff. Judging, however, from our experience with other industries that depend upon local sources of raw material, we would caution that a thorough assessment of maize varieties be made prior to any large scale development. I would, in fact reinforce the call for a well defined grains policy in Ghana. Different varieties of raw materials often respond differently to industrial processing - a fact well evidenced with tomatoes in Ghana. While we select therefore for higher agronomic characteristics including increased yield, disease resistance and storability, we should not lose sight of the processing and perhaps more important the human response or receptivity to the product. As it appears, there is a lot of work ahead, and the sooner we go to it the better it will be for the nation.

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TABLE 1

NUTRIENT VALUES OF SOME CEREALS OCCURRING IN GHANA

EXPRESSED ON THE BASIS OF 100 gm OF SAMPLE

	MAIZE (Zea mays)		GUINEA CORN (Sorghum bicolor)		MILLET (Pennisetum americanum)	RICE (Oryza sativa)	
	White	Yellow	White	Yellow		White Imported	White Local
Food Energy (Calories)	353	353	371	368	375	362	362
Moisture, gm	12.4	11.8	10.9	11.7	11.3	12.2	12.4
Protein, gm.	9.0	10.4	10.0	10.0	7.5	7.4	6.8
Fat, gm.	4.0	3.9	2.9	2.8	4.2	0.6	0.2
Ash, gm.	1.3	1.4	1.4	1.3	1.5	0.8	0.4
CHO, gm (incl. fiber	73.3	72.5	74.8	74.2	75.5	79.0	80.2
Fiber, gm.	-	-	-	-	-	-	0.1
Calcium, mg.	6	8	24	25	26	17	8
Phosphorus, mg	101	126	275	265	-	90	85
Iron, mg.	2.0	30.0	22.8	5.0	-	2.0	0.4

Extracted from "Food Composition Table" prepared by the Food Analysis Section, Food Research Institute (C.S.I.R.), Accra (1970).

TABLE 2

PROXIMATE COMPOSITION OF MARKET CLASSES OF RAW MAIZE IN GHANA

	LOCALS			IMPORT		
	Kulumâgbi	Kpokploku	Yellow*	Diacol 153	Composite II	Yellow*
Moisture, gm	11.4	12.5	11.8	11.0	12.0	12.6
Protein, gm	9.6	8.9	10.4	9.3	10.4	9.0
Fat, gm	4.1	3.8	3.9	4.2	4.4	3.3
Ash, gm	1.2	1.1	1.4	1.1	1.2	1.0
CHO, gm	-	-	72.5	-	-	74.1
Fiber, gm	0.6	1.1	-	1.1	1.2	1.9
Calcium, mg	27	25	8	22	25	16
Phosphorus, mg	236.1	219.7	126	194.7	198.0	205
Iron, mg.	-	-	30.0	-	-	4.7

Source: Food Analysis Section, Food Research Institute - courtesy of Mr. G.T. Adams (Senior Technical Officer).

* See under Table I for reference.

TABLE 3

ANALYSIS OF MAIZE FOR PROCESSING & ORGANOLEPTIC TRAITS*

	DIACOL 153	COMPOSITE II	KUKUDABI	KPOKPLOKU
Section A				
NATURE OF THE RAW KERNEL				
Appearance score (subjective)	4	4	1	1
Total bacterial count, per gm.	10	220	96,000	20,000
Mould numbers per gram	41,000	1,910	536,000	83,000
Section B				
CONDITIONING OF KERNEL				
Initial weight of batch, lb	4.0	4.0	4.0	4.0
Wt. after 47½ hrs. soaking and conditioning in water, lb	5.8	5.8	5.8	5.8
% increase in wt. of kernel	45.0	45.0	45.0	45.0
Score for observed degree of conditioning (subjective)	2	2	4	2
Section C				
PREPARATION OF DOUGH				
Amount of water added to dough from conditioned and milled kernel, lb	1.0	1.2	1.2	1.0
Wt. of dough after fermentation, lb	6.2	6.6	6.8	6.3
% Gain over raw kernel wt.	55.0	65.0	70.0	57.5
Score for observed degree of fermentation (subjective)	1	3	4	1
Section D				
PREPARATION OF KENKEY				
Quantity of kenkey prepared from 1 lb wt. of dough, lb.	1.6	1.7	2 0	1.9
% Gain in wt. over quantity used	60 0	70 0	100 0	90 0

* Subjective scores:

4 = Excellent; 3 = Good: 2 = Fair; 1 = Poor.

ANALYSIS OF MAIZE FOR PROCESSING & ORGANOLEPTIC TRIALS - contd.

Section E

SOME CHEMICAL ASPECTS OF THE PREPARED KENKEY

	DIACOL 153	COMPOSITE II	KUKUDABI	KPOKPLOKU
Moisture	73.7	73.7	78.9	72.5
Protein	2.6	3.2	3.1	2.6
Fat	0.48	0.30	0 48	0.24
Ash	0.30	0.43	0.33	0 30
Fiber	0.30	0.43	0 13	0 06
Calcium, mg	15 0	20.0	20.0	17 0
Phosphorus, mg	43 1	58.4	53.5	53.2
Acidity (as lactic acid, %)	0.05	0 05	0.02	0.04
pH	4.0	3.8	4.0	4.0

Section F

CONSUMER SCORES OF FINISHED KENKEY (Subjective)

Stickiness	4	2	3	1
Smoothness	2	1	4	3
Sourness	2	3	4	1
Creaminess	4	3	1	2
Freshness	2	1	4	3
Average of Scores	2.8	2.0	4.0	2.0
Overall Acceptability:	2.0	3.0	4.0	1.0

Note : Subjective Scores :

4 = Excellent; 3 = Good 2 = Fair; 1 = Poor.

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