Impact, challenges and prospects of maize research and development in West and Central Africa

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Pasting and food processing characteristics of selected maize varieties

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Abstract

Eight white endosperm varieties of maize (*Zea mays* L.) developed at the Crops Research Institute, Kumasi, Ghana in 1997 were evaluated for physical, rheological and food processing characteristics. There was a wide variation in grain size with 1000-grain weight ranging from 205.1 g for the local check variety to 320.8 g for Obatanpa. On sensory evaluation of the varieties, GH 2328-88 was found to be the most desirable for the preparation of dumpling, kenkey and thin porridge, koko. Obatanpa and GH 132-28 were the least preferred for kenkey among the varieties evaluated. Abeleehi was the least desirable variety for thin porridge preparation. The local check variety had the lowest peak viscosity of 310 BU while Obatanpa had the highest peak viscosity of 450 BU. The local check variety and GH 132-28 had low breakdown values of 180 BU and 185 BU respectively. Although GH 132-28, had a low breakdown value it was not one of the varieties preferred for the preparation of kenkey.

Résumé

Huit variétés de maïs (*Zea mays*) developé à l'institut de recherche sur les cultures, à Kumasi, au Ghana en 1997 ont été évaluées pour leurs caractéristiques physiques, rhéologiques et pour leur aptitude à la transformation alimentaire. Toutes les variétés avaient un endosperme blanc et étaient dépouvues d'insectes. Il y avait une grande variation dans la taille des grains avec 1000 grains dont le poids varait entre 205,1 g pour la variété témoin locale à 320,8 g pour «obatanpa». Après une évaluation sensorielle des variétés, GH 2328-88 s'est trouvée être le cultivar le plus apprécié pour à la fois la préparation de la boulette de pâte, *kenkey* et de la bouillie fine, *koko*. «obatanpa» et GH 132-28 ont été les moins appréciées pour le *kenkey* parmi les variétés évaluées. *Abeleehi* était la variété la moins désirable pour la préparation de la bouillie fine. La variété témoin locale avait la pointe de viscosité la plus faible de 310 BU avec «obatanpa» ayant la pointe de viscosité la plus élévée de 450 BU. La variété témoin locale et GH 132-28 avaient des valeurs faibles (insuccès) de 180 BU et 185 BU respectivement. La variété GH 132-28, bien qu'ayant une faible valeur, elle n'était pas une des variétés préférées pour la preparation du kenkey.

Introduction

Maize (*Zea mays* L.) *is* a major staple food crop in several developing countries, including Ghana. In Ghana, the high cost of inputs for maize cultivation coupled with the low yield has made local maize production expensive and not competitive on the export market (Ashiama, 1986). Efforts in the West African sub-region have involved variety improvement research to obtain high-yielding varieties for cultivation by local farmers.

The success of a breeding program depends not only on high yields and desirable agronomic characteristics but also on the suitability of the varieties for food uses. Consumer acceptability of improved varieties depend on desirable functional and sensory properties for the traditional maize foods. In Ghana, consumer complaints concerning improved varieties have included hard grain texture, difficulty in milling (dry or soaked), chaffy meal with low swelling capacity and poor sensory characteristics of the prepared maize dishes (Sallah and Dzah, 1986).

Improvement has remained a steady activity of maize breeders and other researchers and the need exists to establish and characterize the properties of released varieties and determine their suitability for specific food uses. This will facilitate the promotion of the utilization of high-yielding varieties with desirable food properties by breeders and extension workers.

Starch constitutes the bulk of the carbohydrate content of the maize grain. Chemically, starch usually consists of 70% to 80% branched amylopectin (a non-gelling type) and 20% - 30% amylose (a gel forming type). Starch granules are generally held together by an internal network of interlacing molecules that render them insoluble in cold water and resistant to enzymatic action (Kulp and Ponte Jr., 1981). According to Bhattacharya and Sowbhagya (1979) and Smith (1964), when starch suspension is heated, it begins to swell, yielding a viscous paste, that disintegrates on prolonged heating. It therefore produces a paste that is a mixture of swollen granules, granule fragments and dispersed starch molecules. If the temperature of the paste is subsequently decreased, the elements present in the paste start to associate or retrograde, then increase in viscosity. The significant changes in the viscosity during the whole pasting process are characteristic of the particular type of starch.

The amylograph cooking characteristics of starches and flours has been tentatively related to food quality (Waniska, 1976; Akingbala, 1980). The setback viscosity of cereal starches and flours is high for cereals with acceptable thick porridge making quality and is low for those with acceptable thin porridge and unleavened bread making properties.

In any given type of starch, the individual granule do not begin to swell at the same temperature but rather over a range (Leach, 1965). The pasting temperature is however measured by subtracting 3°C from the temperature at which the instrument indicates the beginning of

gelatinisation (Smith,1964, Bhattacharya and Sowbhaga, 1979). The purpose of this study was to evaluate the pasting and sensory characteristics of maize varieties available in Ghana.

Materials and methods

Eight varieties of maize namely, GH 110-5, Obatanpa, GH 132-28, GH 2328-88, Abeleehi, NAES EE W SR, Dorke and a local check variety were evaluated for their rheological and sensory characteristics. The rheological characteristics were determined by milling the maize grains whole in a laboratory attrition mill. An 8% suspension of flour was made and heated in a Brabender Viscoamylograph to 95°C and held at that temperature for 20 minutes. The resultant paste was then cooled to 50°C. The speed of rotation was 75 rpm and a 500 cmg sensitivity cartridge was used.

The viscosity of the paste was recorded by the instrument through the heating and cooling cycles. Other derived characteristics were also computed from the instrument readings. The parameters recorded and computed were as follows:

- Pasting Temperature- (the temperature of initial gelatinisation on the instrument) - 3°C
- Peak Viscosity (P)- the highest viscosity during heating.
- Hot paste viscosity (H) - the viscosity after holding at 95°C for 20 min.
- Cold Paste viscosity (C)- the viscosity after cooling to 50°C.
- Breakdown (BD)- (P-H)
- Breakdown ratio - (H/P)
- Relative breakdown (BDr)- (P-H) / (C-H)
- Setback (SB)- (C-P)
- Total setback (SBt)- (C-H)
- Setback ratio - (C/P)
- Total setback ratio - (C/H)

Two common traditional maize foods, *"koko", a thin porridge* and *"kenkey", a thick porridge* were prepared and used to evaluate consumer preference for the maize varieties.

Sensory preferences for aroma, taste, texture and overall acceptability were recorded on a 9-point hedonic scale (1 = dislike extremely and 9 = like extremely).

Results and discussion

Table 1 shows the pasting characteristics of the 8 maize varieties evaluated. The pasting temperatures ranged from 80.5°C for GH 2328-88 to 88.2°C for Dorke SR. Generally, peak viscosities measure the ability of starches to form pastes during cooking. Starches with high peak viscosities form thick pastes on cooking.

The peak viscosities for the maize varieties were low with Obatanpa having the highest peak viscosity of 450 Brabender Units (BU) whilst the local check variety had a peak viscosity of 310 BU.

Table 1. Pasting characteristics of some maize varieties

Variety	Pasting Temperature (°C)	Peak Viscosity (BU) [P]	Hot Paste Viscosity (BU) [H]	Cold Paste Viscosity (BU) [C]
GH 110-5	86.0	400	160	380
Obatanpa	81.1	450	160	340
GH 132-28	81.1	25	140	300
GH 2328-88	80.5	360	160	330
Abeleehi	85.9	360	140	340
NAES EE W SR	86.9	420	190	360
Dorke SR	88.2	435	158	420
Local	82.5	310	130	270

The breakdown of the paste is the difference between the peak viscosity and the hot paste viscosity and is a measure of the stability of the paste after cooking at 95°C (Table 2). Obatanpa had the highest breakdown value of 290 BU indicating that it had the least stable starch among the varieties followed by Dorke SR with a value of 277 BU. The paste of the local variety had the lowest breakdown value of 180 BU indicating that it was the most stable. GH 132-28 with a breakdown value of 185 BU was comparable to the local variety.

The cold paste viscosity is the paste viscosity after cooling to 50°C. The difference between this and the peak viscosity and the hot paste viscosity are the setback and total setback respectively. These two indices are measures of starch retrogradation (Bhattacharya and Sowbhagya, 1979). Total setback and setback values also have high positive correlations with the amylose content of the grain. Dorke SR had the highest total setback value of 262 BU suggesting that it would have the most floury endosperm while the local variety had the least value of 140 BU. This suggests that the local variety may have a vitreous endosperm.

Table 3 shows the sensory characteristics of kenkey made from the varieties. Trained panelists ranked the various characteristics on a 9 point Hedonic scale of 1 (least preferred) to 9 (most preferred). NAES EE W SR and Dorke SR had the best physical appearances of 7.45 and 7.54 respectively. GH 132-28 was least attractive with a score of 3.80. Regarding the overall acceptability of the varieties for kenkey preparation, GH 2328-88 was adjudged the best with a score of 7.20 followed by NAES EE W SR with a score of 6.81. Obatanpa and GH 132-28 were found to be the least preferred for kenkey with a score of 5.00.

Table 2. Viscoamylographic indices of some maize varieties.

Variety	Breakdown (P-H) [BU]	Breakdown Ratio (H/P)	Relative Breakdown (H-P)/(C-H)	Setback (C-P) [BU]	Total Setback (C-H) [BU]	Setback Ratio (C/P)	Total Setback Ratio (C/H)
GH 110-5	240	0.40	1.09	-20	220	0.95	2.37
Obatanpa	290	0.35	1.61	-110	180	0.75	2.12
GH 132-28	185	0.43	1.15	-25	160	0.92	2.14
GH 2328-88	200	0.44	1.17	-30	170	0.92	2.06
Abeleehi	220	0.39	1.10	-20	200	0.94	2.43
NAES EE WSR	230	0.45	1.35	-60	170	0.86	1.89
Dorke SR	277	0.36	1.06	-15	262	0.96	2.66
Local	180	0.42	1.28	-40	140	0.87	2.08

Table 3. Sensory characteristics scores* of some maize varieties (Kenkey)

Variety	Appea-rance	Odour	Taste	Sour-ness	Finger feel	Mouth feel	Overall Accepta-bility
GH 110-5	6.50	6.40	6.80	6.10	7.10	6.40	6.30
GH 132-28	3.80	4.70	5.50	5.30	5.40	5.50	5.00
GH 2328-88	7.30	7.10	7.30	7.40	7.10	6.70	7.20
Abeleehi	6.90	4.63	5.54	5.54	6.00	6.00	5.27
NAES EE WSR	7.45	7.18	6.90	7.00	7.09	6.63	6.81
Dorke SR	7.54	7.27	6.09	5.81	6.27	5.90	6.09
Local	7.18	6.63	5.72	6.27	6.63	6.63	5.90

*Scale of 9 to 1; where 9=like extremely and 1=dislike extremely.

Table 4. Sensory characteristics scores* of maize varieties evaluated for 'koko' preparation

Variety	Appea-rance	Odour	Taste	Sour-ness	Mouth feel	Overall Acceptability
GH 110-5	5.60	6.40	6.50	6.20	6.50	6.40
Obatanpa	7.80	7.60	7.50	7.50	7.30	7.50
GH 132-28	5.00	6.40	6.20	6.30	7.20	6.20
GH 2328-88	7.80	7.70	7.80	7.70	7.60	7.80
Abeleehi	7.18	3.72	5.00	5.27	5.54	5.18
NAES EE W SR	7.90	8.00	7.18	7.09	7.45	7.45
Dorke SR	6.63	6.54	5.81	5.54	6.45	5.90
Local	7.45	7.27	6.63	6.72	6.81	6.63

*Scale of 9 to 1; where 9=like extremely and 1=dislike extremely.

The sensory characteristics of the varieties with respect to porridge (koko) quality are shown in Table 4. NAES EE W SR had the best flavour with a score of 8.00. GH 2328-88 was found to have the overall best acceptability for porridge preparation with a score of 7.80 followed by Obatanpa with 7.50. Abeleehi was least preferred with a score of 5.18. This was as a result of the fact that the flavor was adjudged to be undesirable by the panelists.

Table 5. Physical Characteristics of Maize Varieties

Variety	Endosperm Colour	1000 Grain Weight (g)	Insects
GH 110-5	White	290.5	Absent
Obatanpa	White	320.8	Absent
GH 132-28	White	278.4	Absent
GH 2328-88	White	272.8	Absent
Abeleehi	White	259.7	Absent
NAES EE W SR	White	272.7	Absent
Dorke SR	White	307.1	Absent
Local	White	205.1	Absent

Table 5 shows the physical characteristics of the varieties. All the varieties had white endosperms. The grains were very clean with a complete absence of insects. However, the 1000-grain weight showed some variability. Obatanpa had the highest 1000-grain weight of 320.8 followed by Dorke SR with 307.1. The local check variety had the smallest grain size with a 1000-grain weight of 205.1 grams.

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