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Genotypic Performance of 15 Maize Cultivars for Fresh Maize Consumption in Owerri West, South Eastern Nigeria

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Abstract: Generally, bad taste, hard kernels and unattractive colour are among the factors which affect fresh maize consumption and acceptability pattern of genotypes in Nigeria. Variation in palatable qualities and sensory attributes of 15 boiled green maize cultivars were studied. The palatable qualities evaluated were colour, kernel hardness, kernel size, taste and appeal. This was done by using questionnaires distributed to 20-man panelist. The judgments obtained from the survey through numerical scoring test were analyzed statistically using Genstat [1] Discovery Edition. Highly significant differences were obtained among the genotypes for grain size. Genotype, Oka-Bende(V_1) had the largest grain size(1.15) followed by Uk-Ibere(V_8)(1.20). Smallest grain size was recorded in Aro-Egbema(V_7)(2.85). Also highly significant variations were observed for hardness, appeal, taste and preference(overall acceptability). Nse-Nguru(V_5) had the best and highest consumption acceptability with Rank Summation Index (RSI) value of 30. Ag-Flat(V_{10}) was the least preferred for hardness, appeal, taste and overall acceptability with RSI value of 69. Preference was highly significant and positively correlated with appeal, colour, taste and grain size. Rank Summation Index analysis revealed that the taste and colour were the most significant attributes in overall acceptability of a genotype for fresh maize consumption.

Key words: Freshmaize · Palatability test · Palatable qualities · Acceptability · Rank Summation Index(RSI) · Cultivars

INTRODUCTION

Green maize is a warm-season vegetable that can be grown easily in any garden. The ears are picked during the "milk stage'' when the kernels are fully formed but not fully matured. This stage occurs about 20 days after the appearance of the first silk strands. Matured Vegetable maize which is high value agricultural product is harvested before the crop reaches maturity [2]. The estimates of the global value of green maize suggest that maize is one of the five most profitable vegetable in the world [3]. The "big five" producers of vegetable maize are China, the USA, Mexico, Peru and Thailand. Green maize is eaten in more than half the world's maize producing countries. As a source of food, it provides relief during the "hungry season" for millions of farm households in sub-Saharan African and other resources-poor areas where maize is the main food source and regarded as indispensable crop during the hunger period prevalent in most states before other crops are ready for harvesting [4].

According to FAOSTAT [3], the areas (hectares) under vegetable maize production compared to two top vegetables in Nigeria are 161,000, 127,000 and 41,000 for vegetable maize, tomato and onions respectively. Grain; size, toughness, taste, colour and appeal are some of the quality parameters of importance that affect consumption acceptability pattern of a genotype [5]. However, there are geographical preferences for certain colours. The constraints to fresh maize consumption pattern include; bad taste, hard kernels and unattractive colour [6]. Higher sugar content and low chaff seem to be preferred [7]. In the market, large ears may bring a better price than small ears.

However, green maize is not grown mainly for commercial purpose in Nigeria. But, potentially it can be an export crop (Fresh and canned) to other countries if a good quality variety can be identified or developed [8]. Quality is the ultimate criterion of the desirability of any food or its products to consumer. Appearance (appeal), which can be judged by the eye e.g. colour, shape, size, uniformity and absence of defects , is of first importance

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in the food selection [9]. Flavour embraces the senses of the taste, smell and feeling [10].

Therefore, there is a good prospect for enhancing the consumption of fresh maize through the selection of genotypes that accumulate high levels of good palatable qualities [11] and hence, the need of this study.

MATERIALS AND METHODS

Fifteen (15) maize genotypes used in the study were sourced from Imo state and AbiaState located in maize producing areas of South Eastern Nigeria where they are cultivated mainly by the local farmers (Table 1).

The field experiment was conducted in 2010 at the Teaching and Research Farm of Federal University of Technology, Owerri, located at latitude 05° 27^{1}N and longitude 07° 2^{1}E with altitude 90.91m above sea level (ASL). The field experiment was laid out in a Randomized Completely Block Design (RCBD) with three replications. The plants were spaced 0.25 x 0.75m, which gave plant population of 53,333 plants per hectare. Adequate field maintenance was carried out to ensure good crop performance. Individual plants of the different genotypes were selfed to maintain their genetic integrity.

Palatability Tests: This was carried out on the day of harvest in The School of Agriculture and Agricultural Technology in Federal University of Technology, Owerri. The maize was boiled for about one hour (1 hour) after which it was displayed on a table with each variety placed on a separate tray with appropriate genotypic tag number.

The test was performed by twenty (20) different people in the School of Agriculture which included eight (8) academic staff of the faculty and twelve (12) post graduate students of the same faculty. Printed questionnaires were distributed to the testers, where information concerning every genotype was filled after testing each of the boiled maize genotypes. Adequate drinking water was provided to enable the testers rinse their mouth properly after testing each variety to ensure the taste of one variety is not muddled with the taste of another. The bases for the test were colour, grain size, appeal, taste, hardness and preference. Colour was classified into white, yellow and mixed colour which was scored as 1, 2 and 3, respectively. Appeal was also divided into strongly, mildly and not appeals with scale rating of 1, 2 and 3 respectively. Grain size which was partitioned into large, medium and small was graded on scale of 1, 2 and 3 respectively. Very soft, soft, hard and very hard which constituted hardness were rated as 1, 2, 3 and 4 respectively. However, taste was divided into sugary, tasteless and sour with respective scale rating of 1, 2 and 3 while preference classified as excellent, good and bad received scale rating of 1, 2 and 3, respectively.

Table 1: Genotype code, names of the genotype and collection site of the maize genotypes.

Genotype code	Name of the genotype	Collection site
V_1	Oka-Bende	Bende, Abia State
V_2	Um-Olok	Umuahia, Abia State
V_3	Oka- Ngwa	Ngwa, Abia State
V_4	Oha-Gbem	Ohaji, Egbema, Imo state
V_5	Nse- Nguru	Mbaise, Imo State
V_6	Iku-Ukwuato	IbekuUkwuato, Imo State
V_7	Aro-Egbema	Aghoro, Imo State
V_8	Uk-Ibere	Ikwuano, Abia State
V_9	Ezi-Oka	Eziobodo, Imo State
V_{10}	Ag-Flat	Ndoro, Abia State
V_{11}	Ka-Eme	Emekuku, Imo State
V_{12}	Um-Dik	Umudike, Abia State
V_{13}	Ukworu	Obuohia, Abia State
V_{14}	Oka- Aki	Ibeku, Abia State
V_{15}	Awaka	Awaka, Imo state

Evaluation of the Fresh Maize Genotypes for Qualities: The respondents(panels) analyzed these maize genotypes through properly planned experiments and their judgments are quantified by appropriate statistical analysis for determining the significance of variation of average scores and the contribution of the individual quality characteristics to the overall quality.

The data from the survey were analyzed statistically to discover the significance, preference and rejection. Preliminary evaluation was done to decide the optimum state , quantity of sample to be prepared and presentation of samples so that homogeneity , appropriateness and randomization are achieved to take care of different types of bias that could affect the judgments of personnel in the test panels.

Experimental (Laboratory) Set-Up: The set-up was simple; the importance consideration being that independent judgment in an atmosphere of relaxed concentration and free from any distraction was ensured. The laboratory was identical, uniformly illuminated and provided with drinking water, a glass, clean towels and a basin for convenient examination.

Respondents (Panel) Selection: The requirements for panel membership were; (i) good health, (ii) average sensitivity, (iii) high degree of personal integrity, (iv)

intellectual curiosity and interest in sensory evaluation work, (v) ability and willingness to spend time in evaluation and for acuity and consistency.

Sample (15 Fresh Maize Genotypes): The number of samples required for the entire test was carefully worked out and obtained prior to the start of the evaluation. The number of sample used is dependent upon the sensory nature of the test product and the evaluation method used. Proper sampling of the test samples was ensured and samples for presentation were from homogeneous lots. They were prepared in exactly the same manner for each lot and for each examination. Appropriateness of time, temperature and the quantity was taken into account in the presentation of samples.

Evaluationcard (Questionnaire): The questionnaire or score card was prepared carefully for each test. The card was clearly typed, simple and used unambiguous terms and directions in the desired sequence of action as a guide to the evaluation.

Numerical Scoring Test: Comparisons of two or more similar products are required to be made to establish whether or not two or more materials are perceptibly different in some respect. Numerical scoring test, where each sample (maize genotype) is evaluated on a specific scale for a particular characteristics indicating the rating of the samples was used. The best genotype intended for use was selected using this method.

Data Analysis: The results from questionnaires were collated and subjected to Rank summation index (RSI) using "GenStat" [1] software and SPSS (Statistical Package for Social Sciences), 2007 Version. The best among the 15 genotypes was identified.

RESULTS

The results of the sensory evaluation (palatability) of 15 fresh maize genotypes are presented in Tables 2. The Table contains the panel(respondents) evaluation of samples for colour and grain size. However, genotype Oka-Bende(V)$_1$ had the largest grain size(1.15) followed by genotypes; Uk-Ibere(V_8) (1.20) and Ukworu (V_{13}) (1.30) respectively. The smallest grain size was recorded for Aro-Egbema(V_7)(2.85). Panel evaluation of samples for hardness indicates that genotypes Aro-Egbema(V_7)(1.20) and Ezi-Oka(V_9)(1.40) were very soft and significantly different from other genotypes but were not significantly different from each other. However, Nse-Nguru(V_5) and Oka-Ngwa(V_3) were soft with numerical scoring mean values of 1.75 and 1.90 respectively. Conversely, Um-Dik(V_{12}) and Ag-Flat(V_{10}) were observed to be very hard with numerical scoring mean values of 3.00 and 3.10 respectively.

The respondents' evaluation of samples for appeal is a measure of uniformity, attractiveness and absence of defects. Ka-Eme(V_{11}), Oka-Aki(V_{14}) and Nse-Nguru(V_5) were the most attractive with absence of defects and with numerical scoring mean values of 1.40, 1.60 and 1.70, respectively. With regards to significance, only Ka-Eme(V_{11}) and Oka-Aki(V_{14}) were significantly superior from other genotypes. Unattractiveness (unappealing) was recorded in Uk-Ibere(V_8), Oha-Gbem(V_4) and Ag-Flat(V_{10}).Oka-Bende(V_1) and Aro-Egbema(V_7) were mildly appealing with mean values of 1.95 and 1.90 respectively. The evaluation of the samples for taste presented in the Table indicates that most of the genotypes were similar in taste. Aro-Egbema(V_7), Iku-Ukwuato(V_6) and Ezi-Oka(V_9) were the sweetest genotypes with the numerical scoring mean values of 1.35, 1.40 and 1.40 respectively. Um-Dik(V_{12}) and Oka-Bende(V_1) were observed to be tasteless. Incidently, Oha-Egbema(V_4) and Ag-Flat(V_{10}) were sour with observable mean values of 2.05 and 2.11, respectively.

The mean consumption acceptability (preference) of the genotypes as indicated by the correspondents (panel) is presented in the Table 2. Oka-Aki(V_{14}) and Nse-Nguru(V_5) had the highest consumption acceptability (preference) with numerical scoring mean values of 1.60 and 1.65, respectively. Ukworu(V_{13}), Oka-Ngwa(V_3) and Uk-Ibere (V_8) were less preferred with mean values of 2.05, 2.10 and 2.10, respectively. However, Oha-Gbem(V_4), Um-Dik(V_{12}) and Ag-Flat(V_{10}) which had respective numerical scoring mean values of 2.25, 2.30 and 2.50 were not acceptable and not preferred for fresh maize consumption.

Correlation: The Pearson Correlation Matrix of the sensory evaluation and the linear correlation coefficient (r) among the qualities are given in Table 3. Significant and positive correlations were found between colour and appeal (r = 0.54*). Grain size were also observed to be significantly and positively correlated with appeal (r =0.62*) and colour (r = 0.58*).Taste is significantly and positively correlated with appeal (r = 0.77**) but significantly and negatively correlated with colour (r = -0.73**) and grain size (r = 0.82**). Hardness was found to be significantly and positively correlated with

Table 2: Panel evaluation of 15 fresh maize genotype samples for palatable qualities

Genotype	Colour[a]	Grain size[1]	Hardness[2]	Appeal[3]	Taste[4]	Preference[5]
Oka-Bende(v1)	1.95	1.15	2.35	1.95	1.85	1.85
Um-Olok(V_2)	1.30	1.45	2.55	2.00	1.80	2.15
Oka-Ngwa(V_3)	2.20	1.80	1.90	2.05	2.00	2.10
Oha-Gbem(V_4)	1.05	1.75	2.40	2.15	2.05	2.25
Nse-Nguru(V_5)	2.00	2.60	1.75	1.70	1.42	1.65
Iku-Ukwuato(V_6)	2.05	2.75	2.05	1.80	1.40	1.85
Aro-Egbema(V_7)	2.60	2.85	1.20	1.90	1.35	1.75
Uk-Ibere(V_8)	2.25	1.20	2.50	2.11	1.90	2.10
Ezi-Oka(V_9)	2.60	2.80	1.40	1.79	1.40	1.85
Ag-Flat(V_{10})	1.00	1.95	3.10	2.37	2.11	2.50
Ka-Eme(V_{11})	2.10	2.75	2.16	1.40	1.53	1.80
Um-Dik(V_{12})	1.11	1.35	3.00	2.05	1.84	2.30
Ukworu(V_{13})	1.15	1.30	2.30	1.95	2.00	2.05
Oka-Aki(V_{14})	2.20	2.50	1.95	1.60	1.47	1.60
Awaka(V_{15})	2.60	2.30	2.45	1.85	1.50	1.70
Overall Mean	1.88	2.03	2.20	1.91	1.71	1.97
C V %	32.9	24.1	29.5	30.1	36.8	26.3
$LSD_{(0.05)}$	0.38	0.31	0.41	0.36	0.39	0.32

[a]Scale rating 1 to 3 with 1 = white, 2 = yellow, 3= bi-colour(mixed).

[1]Scale rating 1 to 3 with 1 = large, 2 = medium, 3 = small grain size.

[2]Scale rating 1 to 4 with 1 = very soft, 2 = soft, 3 = hard, 4 = very hard

[3]Scale rating 1 to 3 with 1 = strong appeal, 2 = mild appeal, 3 = not appealing

[4]Scale rating 1 to 3 with 1 = sugary, 2 = tasteless, 3 = sour

[5]Scale rating 1 to 3 with 1 = highly preferred (acceptable), 2 = moderately acceptable, 3 = unacceptable (rejected)

Table 3: Pearson Correlation matrix of Palatability test of 15 fresh maize genotypes

Grain traits	Appeal	Colour	Grain size	Taste	Hardness	Preference
Appeal	-					
Colour	0.54*	-				
Grain size	0.62*	0.58*	-			
Taste	0.77**	0.73**	0.82**	-		
Hardness	0.54*	0.72**	0.67**	0.69**	-	
Preference	0.83**	0.77**	0.61*	0.84**	-0.71**	-

Table 4: Rank Summation Index (RSI) of consumption acceptability of 15 fresh maize genotypes

Genotype	Colour	Rank 1	Grain size	Rank 2	Hardness	Rank 3	Appeal	Rank 4	Taste	Rank 5	Preference	Rank 6	Rank Summation Idex
Nse-Nguru(V_5)	2.00	7	2.60	11	1.75	3	1.70	3	1.42	4	1.65	2	30
Oka-Aki(V_{14})	2.20	10	2.50	10	1.95	5	1.60	2	1.47	5	1.60	1	33
Iku-Ukwuato(V_6)	2.05	8	2.75	12	2.05	6	1.8	5	1.4	2	1.85	6	39
Oka-Bende(v1)	1.95	6	1.15	1	2.35	9	1.95	8	1.85	10	1.85	6	40
Aro-Egbema(V_7)	2.60	13	2.85	15	1.20	1	1.90	7	1.35	1	1.75	4	41
Ezi-Oka(V_9)	2.60	13	2.80	14	1.40	2	1.79	4	1.40	2	1.85	6	41
Ka-Eme(V_{11})	2.10	9	2.75	12	2.16	7	1.40	1	1.53	7	1.80	5	41
Ukworu(V_{13})	1.15	4	1.30	3	2.30	8	1.95	8	2.00	12	2.05	9	44
Awaka(V_{15})	2.60	13	2.30	9	2.45	10	1.85	6	1.50	6	1.70	3	45
Um-Olok(V_2)	1.30	5	1.45	5	2.55	13	2.00	10	1.80	8	2.15	12	53
Oka-Ngwa(V_3)	2.20	10	1.80	7	1.90	4	2.05	11	1.84	12	2.30	10	54
Um-Dik(V_{12})	1.11	3	1.35	4	3.00	14	2.05	11	1.84	9	2.30	14	55
Oha-Gbem(V_4)	1.05	2	1.75	6	2.40	11	2.15	14	2.05	14	2.25	13	60
Uk-Ibere(V_8)	2.25	12	1.20	2	2.50	12	2.11	13	1.90	11	2.10	10	60
Ag-Flat(V_{10})	1.00	1	1.95	8	3.10	15	2.37	15	2.11	15	2.50	15	69

appeal (r= 0.54*) and taste (r = 0.69**). However, hardness had significantly and negatively correlations with colour and grain size. Preference was significant and had positive relationships with appeal (r = 0.83**), colour (r = 0.77**), grain size (r = 0.61) and taste (r = 0.84**). Conversely, significant and negative correlation was observed between preference and hardness (r = -0.71**).

Table 4 presents Rank Summation Index (RSI) of the six qualities evaluated for sensory evaluation among the 15 fresh maize genotypes. The ranking of the 15 fresh maize genotypes for consumption desirability and acceptability parameters namely; colour, grain size, hardness, appeal, taste and preference showed that genotype Nse-Nguru(V_5) from Mbaise in Imo state had the best and highest consumption acceptability with a rank summation index value of 30. This was followed by genotypes Oka-Aki(V_{14}) (from Ibeku, Abia State) and Iku-Ukwuato(V 6) (from Aghoro, Imo State), Oka-Bende(V_1) (from Bende, Abia State), Aro-Egbema(V_7), Ezi –Oka(V_9) and Ka-Eme (V_{11})(all from Imo State) and Ukworu (V_{13}) from Abia State, in that order. Selection of the top 20% (3 genotypes in all) include Nse-Nguru(V_5), from Imo State and Oka-Aki(V_{14}) and Iku -Ukwuato(V_6) from Abia State .Genotype Ag-Flat(V_{10}) from Ndoro in Abia State is the worst accepted (rejected) having scored a RSI values of 69.

DISCUSSION

Fresh maize is mainly used for fresh consumption. Several physical characteristics and chemical composition of fresh maize genotypes are required for acceptability or rejection of a genotype for fresh consumption. A fresh maize genotype must be superior in quality and must also posses special characteristics before it will be acceptable to consumers. The emphasis on palatable value of fresh maize has increased in recent years as a result of greater concern for the nutritional needs of people who obtain the major portion of their diet from fresh maize and to identify good palatable quality genotype(s). The quality characteristics of a variety of fresh maize are complex. It requires a long series of testing procedures which evaluate many different quality components of each genotype sample. These include diverse characteristics as kernel size, colour, hardness, taste and appeal.

The test permit the consumers and breeders to select the strains with the best potential quality, which may still be subjected to more thorough quality testing procedures after their superior agronomic characteristics have been demonstrated. However, the genotypes evaluated portrayed some degree of diversity in terms of palatable qualities. There is a positive and significant relationship between preference and colour, grain size and taste. Conversely, negative correlations exist between preference and hardness.

Although very little is known about the characteristics of the kernel associated with desirable taste; but generally, a yellow fresh maize [a good source of vitamin A precursors (carotene)], with a large grain size, soft grain, good taste and good appeal is preferred. This is in agreement with earlier findings by Onyishi and Obi (1990) which reported that there is a direct quantitative relationship between vitamin A(carotene in fresh yellow maize)and acceptability.

These materials identified with fresh, good, palatable qualities should be subjected to further improvement programme or introgressed into other breeding population.

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