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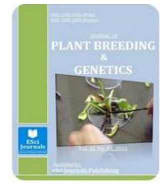

MAIZE GENOTYPES COLLECTION AND CHARACTERIZATION FROM LOCAL GOVERNMENT AREAS IN EBONYI STATE, NIGERIA

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A B S T R A C T

The study was aimed at sourcing and characterizing genotypes from different parts of Ebonyi State for use in future maize breeding. Therefore, conscious expeditions were made to the old 13 local government areas (LGAs) of Ebonyi State (Abakaliki, Afikpo North, Afikpo South, Ebonyi, Ezza North, Ezza South, Ikwo, Ishielu, Ivo, Ohaozara, Ohaukwu and Onicha). In each LGA, at least two cobs of each maize genotype were collected from their local market. A total of 26 local maize cultivars were collected. The maize genotypes collected from the 13 local councils were characterized based on location, seed colour, seed type, cob length, cob circumference, number of rows per cob, number of seeds per row, 100 seed weight (g) at 15.5% moisture content, kernel density (g/cm^3) at 15.5% moisture content. After characterization, equal quantities of the samples were made from the 26 genotypes and taken to the laboratory for chemical analyses of nutritional contents such as percentage crude protein, oil, amylose and amylopectin. Results obtained showed that Ishiotu I and II both from Afikpo North had the longest cob length, cob circumference and number rows per cob. Ikwo yellow had the highest 100 seed weight and there is no doubt that this would result to higher grain yield. Significant and positive correlation were found between cob circumference and number of rows per cob (r = 0.526**). Number of seeds per row were also found to be significantly and positively correlated with cob length (r = 0.634**) and cob circumference (r = 0.458*). Kernel density was found to be significantly and positively correlated with amylose (r = 0.465*). It was also discovered that amylose had significant and negative correlation with amylopectin (r = -0.995**). Protein correlated positively with oil (r = 0.133), but was not significant. However, Ikwo yellow recorded the highest protein content of 8.06%. The low protein content in some other genotypes presents a great challenge to plant breeders in form of quality improvement. It was therefore concluded that maize genotypes for any breeding and/or improvement for agronomic and quality traits should necessarily include samples from Afikpo North and Ikwo LGAs of Ebonyi State. Also, these areas should be considered for both extensive and intensive cultivation of maize in furtherance of the present administration's transformation agenda on agriculture.

Keywords: Maize, genotypes collection, characterization, agronomic traits, chemical contents.

INTRODUCTION

Maize (*Zea mays* L.), belonging to the family Poaceae includes fifty species with different colours, textures and grain shapes and sizes. Maize was introduced into Africa in the 1500s (IITA, 2011) and has since become one of Africa's dominant food crops. The grains are rich in vitamins A, C and E, carbohydrates, and essential amino acids, but lacking tryptophan and lystine, and contain 9% protein. They are also rich in dietary fiber and calories which are good source of energy (Okporie *et al.,* 2013).

According to Ngwuta *et al.* (2013), maize is the most important cereal crop in Sub-Saharan Africa (SSA) and an important staple food for more than 1.2 billion people in SSA and Latin America. All parts of the crop can be used for food and non-food products, and as such described as a golden crop (Okporie, 2008). In industrial products, maize accounts for 30-50% of low-income household expenditures in Eastern and Southern Africa. The heavy reliance on maize in diet, may lead to malnutrition and vitamin deficiency diseases such as night blindness and kwashiorkor (Obi, 1991) because maize diet is incomplete in the essential amino acid like

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lysine and tryptophan. However, these essential amino acids may be infused through trait based breeding and improved agricultural practices.

Many researchers and plant breeders have worked so assiduously hard in developing several maize varieties of high yielding quality such as opaque-2-mazie. Scientists at the International Institute for Tropical Agriculture, Ibadan, have developed high yielding and disease resistant varieties of maize (IITA, 2011). Although, remarkable success has been achieved by maize breeders with the development of early, intermediate and late maturing varieties, still there is need to develop genotypes or varieties of maize to face the challenges such as unprecedented rapid increase in population coupled with climate changes such as drought, increased salinity in soil, cold and heat stress (Kostova *et al.,* 2006; Losa *et al.,* 2011).

The maize genome is complex, and has a very high level of genetic diversity compared with other crops and model plant species (Chia *et al.,* 2012). The *Zea* genome is in constant flux, with transposable elements changing in genome and affecting genetic diversity (Liu *et al*., 2003). Researchers have genotypically characterized subsets of these maize inbred lines to assist with curatorial management of germplasm collections, to evaluate diversity within breeding programs, and for use in association mapping (Mezmouk *et al.,* 2011; Yan *et al.,* 2011). The objective of the study was to source and characterize genotypes from different parts of Ebonyi State for use in future maize breeding.

MATERIALS AND METHOD

Location: Conscious expedition was made to the whole old thirteen Local Government Areas (LGAs) of Ebonyi State. In each LGA, at least two cobs of each maize genotype were collected from their local market. Therefore, at least a total of twenty six local maize genotypes were collected from the LGAs. The LGAs include Abakaliki, Afikpo North, Afikpo South, Ebonyi, Ezza North, Ezza South, Ikwo, Ishielu, Ivo, Izzi, Ohaozara and Onicha.

Characterization: The maize genotypes collected from the thirteen local councils in Ebonyi State were characterized based on seed colour, seed type, cob length, cob circumference, number of rows per cob, number of seeds per row, 100-seed weight at 15.5% moisture content and kernel density at 15.5% moisture content.

Determination of nutritional contents: After the characterization, equal quantities of samples were made from the twenty six genotypes and taken to the Crop Science laboratory of Ebonyi State University for chemical analysis. The maize seed samples were dried in Gallenkamp oven (Model OV - 440) at 40^0C for 48 hours. The samples were ground to pass through 1mm sieve with a Thomas – Willey laboratory mill, model 4. This fineness is particularly essential in order to provide enough surface area for thorough action of solvents and reagents to be used. The ground samples were preserved in cellophane bags and kept in desiccator. Percentage crude protein, oil, amylose and amylopectin were determined. Crude protein content was determined by the micro Kjeldahl method as described by Pearson (1976). The percentage crude protein was calculated as %N x 6.25. Proximate system for food analysis that employs the continuous solvent extraction using soxhlet's extractor as described by Anon (1990) was used in determining the percentage oil content of the maize genotypes. Amylose contents in the maize samples were determined by the method described by Okporie (2000). The percentage amylopectin was calculated based on the assumption that 100% starch = Amylose (%) + Amylopectin (%).

Data Analysis: Data collected from the parameters listed above in the twenty six local maize genotypes were analysed using descriptive statistical measures such as range, mean, variance, standard deviation and coefficient of variations (Obi, 2002). The data were also subjected to correlation analyses using Gen Stat (2007) software and Statistical Package for Social Science (SPSS), 2007 version.

RESULTS

Agronomic characteristics: The range, mean, variance, standard deviation and confidence interval (C.I) estimates of the agronomic characteristics of the 26 genotypes of maize (*Zea mays* L.) collected from the 13 LGAs of Ebonyi State are as presented in Tables 1 and 2. The twenty six (26) genotypes ranged from 10.6cm to 21.5cm (Table 2). Thirteen (13) genotypes, representing about 50% had cob length greater than the mean (16.67cm) while the other thirteen (13) genotypes representing about 50% had cob lengths less than the mean (16.67cm). However, Ishiotu 1 from Afikpo North LGA had the longest cob length of 21.5cm while Agbe 2 from Afikpo South LGA had the least cob length of 10.6cm. The cob circumference of the 26 genotypes ranged from 10.1cm to 17.5cm (Table 3).

Table 1: Mean agronomic characteristics of the 26 genotypes of maize collected from the 13 LGAs of Ebonyi State.

Germplasm	LGA of origin	Seed colour	Seed type	Cob length (cm)	Cob circum-ference (cm)	No. of rows/cob	No. of seeds/ Row	100 Seed weight (g)	Kernel density (gcm^{-3})
ABAK1	ABAKALIKI	Yellow	Flint	14.1	13.9	13	22	50.42	1.7
ABAK2	""	Light yellow	Flint	17.8	14.5	14	37	45.41	1.59
ISHIOTU1	AFIKPO NORTH	Milky	Dent	21.5	12	10	31	46.71	1.54
ISHIOTU2	""	White	Dent	18.4	17.5	27	32	46.09	1.55
AGBE1	AFIKPO SOUTH	Light yellow	Dent	17.5	13.2	12	29	39.43	1.47
AGBE2	""	Light yellow	Flint	10.6	10.9	9	16	41.65	1.55
NWABA YELLOW	EBONYI	Yellow	Flint	20.8	12.8	12	30	47.47	1.43
NWABA WHITE	""	White	Dent	20.1	14	13	29	30.28	1.51
OSHEGBE1	EZZA NORTH	White	Dent	13.5	12	14	20	41.31	1.49
OSHEGBE2	""	White	Flint	16.5	12	12	25	32.83	1.5
ONUEKE1	EZZA SOUTH	White	Flint	14.3	12.9	13	18	49.02	1.36
ONUEKE2	""	Light yellow	Flint	16.5	11.6	12	19	48.59	1.43
IKWO MAIZE	IKWO	Light yellow	Flint	15	14	15	18	31.64	1.53
IKWO YELLOW	""	Yellow	Flint	18	12.5	11	31	50.75	1.47
MEKEBE	ISHIELU	Light yellow	Flint	14.5	15.1	12	33	43.12	1.44
APA APA OCHA	""	White	Flint	13.5	11.5	15	23	43.58	1.39
ISIOCHI1	IVO	Light yellow	Flint	20.5	13	11	23	42.45	1.48
ISIOCHI2	""	Yellow	Flint	16.5	15.7	13	28	41.05	1.54
IZZI MAIZE1	IZZI	White	Flint	18.4	13.5	14	29	44.71	1.59
IZZI MAIZE2	""	White	Flint	19.8	12.3	16	30	34.83	1.51
OKPOSI 1	OHAOZARA	White	Dent	17.5	13	17	30	49.59	1.64
OKPOSI 2	""	Light yellow	Dent	18	13	19	32	29.45	1.6
MGBO 1	OHAUKWU	White	Flint	16.4	15.8	10	24	29.46	1.61
MGBO 2	""	White	Flint	17.3	11.5	12	23	43.15	1.43
AKPAAKPO 1	ONICHA	Mixed colours	Flint	12.4	12.1	10	23	40.81	1.5
AKPAAKPO 2	""	Mixed colours	Flint	14	10.1	9	21	40.94	1.62
TOTAL	-	-	-	433.4	340.4	345	676	1084.74	39.47
MEAN	-	-	-	16.67	13.09	13.27	26	41.72	1.52

Ishiotu 2 from Afikpo North LGA had the highest cob circumference of 17.5cm while Akpaakpo 2 from Onicha LGA had the least cob circumference of 10.1cm. The mean cob circumference is 13.09cm. Of the 26 genotypes collected, nine, representing about 35% had cob circumference greater than the mean while the other 17 genotypes representing about 65% had cob circumference less than the mean. Number of rows per cob of the 26 genotypes ranged from 9 to 27 (Table 3). Ishiotu 2 from Afikpo North had the highest number of rows per cob (27) while Agbe 2 from Afikpo south LGA had the least (9). However, the mean number of rows per cob is 13.27. Nine genotypes representing about 65% had number of rows per cob less than the mean. The number of seeds per row of the 26 genotypes sourced from the 13 LGAs of Ebonyi State of Nigeria ranged from 16 to 37 (Table 3).

Table 2. Range, Mean, Variance, Standard Deviation, Percentage co-efficient of variation and Confidence interval estimates of agronomic characteristics for the collected 26 genotypes from the 13 LGAs of Ebonyi State.

Range	Cob Length (cm)	Cob circu. (cm)	No. of rows/cob	No. of seeds/ row	100-seed wt(g)	Kernel density (gcm^{-3})
Lower	10.6	10.1	9	16	29.45	1.36
Upper	21.5	17.5	27	37	50.75	1.7
X	16.67	13.09	13.27	26	41.72	1.52
S^2	7.66	2.75	13.56	30.64	43.78	0.0066
S.D	2.77	1.66	3.68	5.54	6.62	0.0081
C.V	16.62	12.68	27.73	21.31	15.87	0.53
Confidence interval						
Lower limit	15.55	12.42	11.78	23.76	39.05	1.517
Upper limit	17.79	13.76	14.76	28.24	44.39	1.523

Table 3. Range, Mean, Variance, Standard deviation, percentage co-efficient of variation and Confidence interval estimates of the chemical characteristics of the collected 26 genotypes from the 13 LGAs of Ebonyi State.

Range	Protein (%)	Oil (%)	Amylose (%)	Amylopectin (%)
Lower	6.27	2.7	13	65
Upper	8.06	5.2	35	87
X	6.99	3.96	25.13	74.98
S^2	0.34	0.35	27.69	29.87
S.D	0.58	0.59	5.26	5.47
C.V	8.30	14.90	20.93	7.29
Confidence interval				
Lower limit	6.76	3.72	23.00	67.77
Upper limit	7.22	4.20	27.13	82.19

Abakaliki maize2 topped other genotypes with 37 seeds per row while Agbe 2 from Afikpo south had the minimum seeds per row (16). The mean number of seeds per row of all the 26 genotypes was 26. Of the 26 genotypes collected, 11 representing about 42% had number of seeds per row greater than the mean while 15, representing about 58% had number of seeds per row less than the mean (Table 1).

The 100 seed weight (g) of the 26 genotypes collected ranged from 29.45g to 50.75g (Table 3). Ikwo yellow had the highest 100 seed weight of 50.75% while Okposi2 from Ohaozara LGA had the least 100 seed weight of 29.45g. However, the mean 100 seed weight of the whole genotypes is 41.72g (Table 3). 14 genotypes representing about 54% had 100 seed weight greater than the mean while 12 representing about 46% of all the genotypes had 100 seed weight less than the mean. The kernel density of the genotypes ranged from 1.36gcm^{-3} to 1.7gcm^{-3}. Abakaliki maize1 was more dense (1.7gcm^{-3}) than other genotypes while Onueke 1 from Ezza South had the least density of 1.36gcm^{-3}. The mean kernel density of the 26 genotypes was 1.52gcm^{-3}. However, of all the 26 genotypes, only 12, representing about 46%, were denser than the mean while 14 representing about 54% had kernel density less than the mean.

Chemical Contents: The range, mean, variance, standard deviation and confidence interval (C.I) estimates of the chemical contents of the 26 genotypes of maize collected from the 13 LGAs of Ebonyi State are as presented in Table 3. The percent protein content of the 26 genotypes of maize ranged from 6.27% to 8.06% (Table 3). Ikwo yellow had the highest protein content of 8.06% while the least was recorded in Abakaliki maize 1 (Figure 1). However, the mean percent protein recorded is 6.99 (Table 3).13 genotypes, representing about 50% of the entire genotypes collected had percent protein content greater than the mean while the other 13, also representing about 50% of the whole genotypes collected had percent protein less than the mean.

The percent oil content ranged from 2.7% to 5.2% (Table 3). Akpaakpo 1 from Onicha LGA had more oil (5.2%) than other genotypes collected while Oshegbe 1 from Ezza North LGA had the least percent oil content of 2.7% (Figure 1). The mean oil content of the 26 genotypes was 3.96%. However, only 12 genotypes, representing about 46% had mean oil content greater than the mean (3.96%), while the other 14, representing about 54% had oil content less than the mean.

The percent amylose of the 26 genotypes ranged from 13% to 35% (Table 3). Highest percent amylose was recorded in Mgbo 1 from Ohaukwu LGA (35%) while the least was observed in Ikwo yellow (13%) (Figure 1). The mean amylose content recoded is 25.13%. Of all the 26 genotypes, 13 representing about 50% had percent amylose greater than the mean while the other 13 genotypes, also representing about 50% had percent amylose less than the mean. The percent amylopectin of the genotypes ranged from 65 to 87. Ikwo yellow from Ikwo LGA had the highest percent amylopectin of 87% (Figure 1) while Mgbo1 had the least percent amylopectin of 65%.

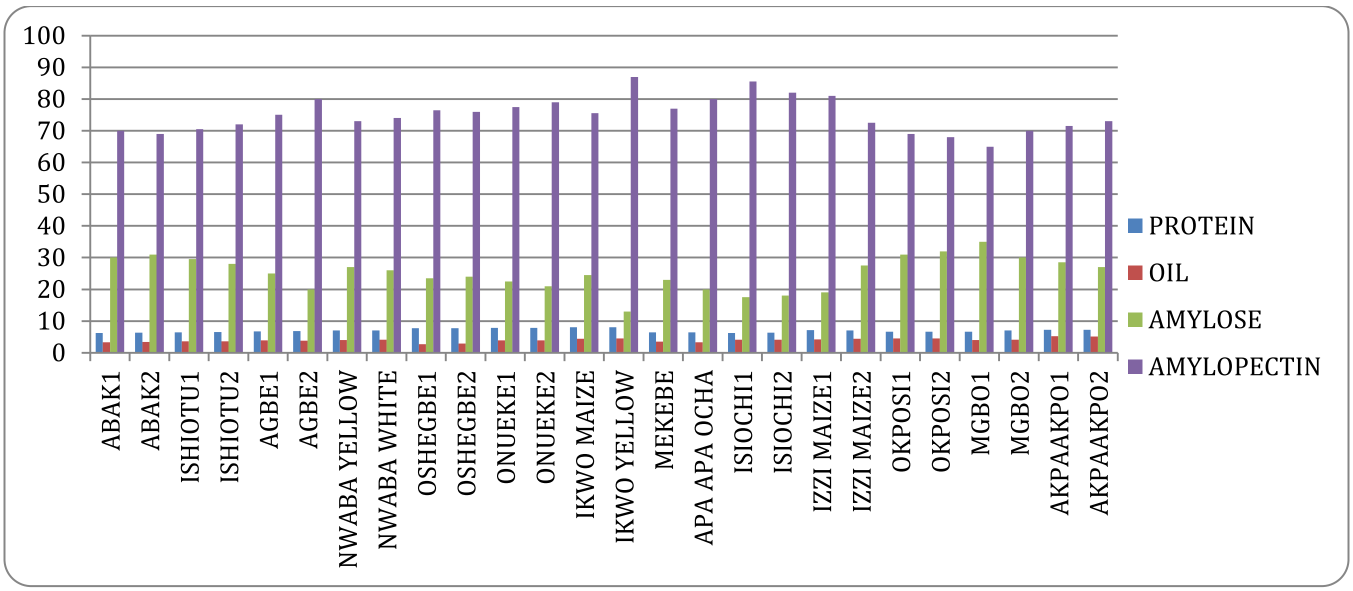

Figure 1. Percent crude protein, oil, amylose and amylopectin contents of the 26 genotypes of maize collected from the 13 LGAs of Ebonyi State.

However, the mean amylopectin content of all the genotypes is 74.98%. Of all the 26 genotypes collected from the 13 LGAs of Ebonyi State, 13 representing about 50% had percent amylopectin greater than the mean while the other 13 genotypes, also representing about 50% had percent amylopectin less than the mean.

CORRELATION ANALYSIS

The Pearson correlation co-efficient of the chemical and agronomic characteristics among the 26 genotypes are as presented in Table 4. Significant and positive correlation were found between cob circumference and number of rows per cob (r = 0.526**).

Number of seeds per row were also found to be significantly and positively correlated with cob length (r = 0.634**) and cob circumference (r = 0.458*). Kernel density was found to be significantly and positively correlated with amylose (r = 0.465*). It was also discovered that amylose had significant and negative correlation with amylopectin (r = -0.995**). Protein correlated positively with oil (r = 0.133), but was not significant (Table 4).

Table 4. Pearson correlation co-efficient of the chemical and agronomic characteristics of the 26 maize genotypes from the 13 LGAs of Ebonyi State.

	Protein	Oil	Amylose	Amylopectin	Cob length (cm)	Cob circf. (cm)	No. of rows/cob	No. of seeds/row	100 seed wt. (g)	Kernel density (g/cm^3)
Protein	1									
Oil	0.133	1								
Amylose	-0.316	0.063	1							
Amylopectin	0.277	-0.056	-0.995**	1						
Cob leng. (cm)	-0.194	0.071	0.120	-0.086	1					
Cob circf. (cm)	-0.383	-0.163	0.176	-0.170	0.241	1				
No. of rows/cob	-0.144	-0.128	0.204	-0.210	0.218	0.526**	1			
No. of seeds/row	-0.438*	-0.002	0.222	-0.225	0.634**	0.458*	0.367	1		
100 seed wt(g)	-0.042	-0.121	-0.281	0.273	-0.027	-0.107	-0.013	0.040	1	
Kernel density	-0.364	0.158	0.465*	-0.458	0.001	0.233	0.139	0.181	-0.136	1

*Correlation is significant at 5% level of probability, **Correlation is significant at 1% level of probability.

DISCUSSION

The wide range of variability existing between the lower and upper limits of the agronomic and chemical characteristics, especially, the number of rows per cob and protein contents is an indication that selection could be successful in evaluation trial of the 26 genotypes. The result is in agreement with Okporie (2000) who observed wide range of variability existing between the lower and upper limits of the agronomic and chemical characteristics especially the plant heights and the protein contents of the 140 parental genotypes, which gave the impetus for the mass selection of the one hundred and thirteen (113) parental genotypes used to continue the breeding programme.

Ishiotu 1 and 2 both from Afikpo North had the highest cob length, cob circumference and number of rows per cob. The result also agrees with Okporie *et al*. (2013) who reported that normal maize has an average number of rows per cob of about 14. Ikwo yellow had the highest 100 seed weight and there is no doubt that this will result to higher grain yield. Okporie (2008) reported positive correlation between 100 seed weight and grain yield of maize. Ikwo yellow recorded the highest protein content of 8.06%. The low protein content in some other genotypes presents a great challenge to plant breeders in form of quality improvement. According to Obi (1991), normal maize has the protein content of about 8 to 11%.

Also, for amylose, the increase in amylopectin content of Ikwo yellow must have affected its amylopectin contents, hence the significant and negative correlation observed between amylose and amylopectin. Okporie and Obi (2004), Zuber *et al*. (1960), Kramer and Whitsler (1949) and Cameroon (1947), all reported that while the percentage of amylose increased, the percentage amylopectin decreased and vice versa. When the amylose proportion of starch decreased, there was a corresponding decrease in endosperm weight and increase in pericarp and germ weight resulting in concurrent increase in oil and protein.

CONCLUSION

The production of high quality maize for human consumption and as feed for livestock should be the objective of every maize breeder. The present protein status of our local maize makes it imperative for supplements to be added to raise the protein percentage to that required by our livestock and human beings as well.

Maize germplasm for any breeding and improvement for agronomic and quality traits should necessarily include samples from Afikpo North and Ikwo Local Government Areas of Ebonyi State. Also, these areas should be considered for both extensive and intensive cultivation of maize in furtherance of the present administration's transformation agenda on agriculture.

It is very likely, also, that these local maize cultivars will be deficient in the essential amino acids – lysine and tryptophan. Therefore, this needs to be investigated.

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