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Physical Features of Some Selected Nigerian Maize Cultivars

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Abstract

A morphological characteristic feature of one hundred Nigerian maize cultivars was established. This repository sought a baseline upon which Nigerian maize cultivars could be classified based on kernel morphology, germinating properties such as shoots length and percent of growth. Out of all the maize cultivars, forty eight were classified as Dent maize, five were found to be Pop maize, thirteen were Waxy maize and six were also classified as Sweet maize while fourteen were found to be Floury and Flint maize respectively. The information would serve as reference for the selection of appropriate Nigerian maize cultivars for specific use in food processing and allied industries.

Keywords

Dent Maize; Pop Maize; Waxy Maize; Floury and Flint Maize

1. Introduction

Maize (*Zea mays* L.) belongs to the cereal family (*Graminea*). It originated in central and south America [1]. It is otherwise known as corn which literally means "that which sustains life" [2]. It is a versatile cereal crop growing across a range of agroecological zones. The plant is primarily a cross pollinating specie and this feature has contributed to its ability to grow well under the most varied condition unlike Barley, Wheat and Sorghum which are limited by climate [3]. It is the cereal with the highest yield potential and cheaper than other cereals hence corn ranks third following wheat and rice in the world production of cereal crop [1]. It is mostly cultivated for its edible fruit otherwise known as grains or kernels. The fruit is easy to process, readily digested and known to be the most important cereals crop in sub-Saharan Africa [4]. These grains are good source of dietary fiber, essential fatty acids, and other important nutrients [5]. The grains are known to have several major groups namely Floury corn, Popcorn, Waxy Corn, Pod Corn, Dent Maize, Flint Maize and Sweet Maize [6] [7]. In Western countries where maize for human food is industrially processed, these aforementioned features contri-

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bute to the extent of their exploitation to form different food and allied products [8] [9]. The knowledge of physical properties constitutes important data in the design of processes and potential utilization [10] [11]. The value of this basic information is important to food scientist, processors and other scientists who may want to exploit these properties and find new uses [12]. Hence there is a need for detailed information on the physical properties of these maize seeds within the kernel characteristics for processing. It is on this basis that this study was carried out so as to promote our local maize cultivar and bridge the gap of information on our locally cultivated maize as regards their exploration in the industry for the benefits of man. In course of the present study, a repository of the characteristic features of one hundred Nigerian maize cultivars after third day of germination was established. This repository established relevant germinative properties such as shoots length and percent of growth. The information would serve as reference for the selection of appropriate Nigerian maize cultivars for specific use in food and allied processing industries.

2. Material and Methods

2.1. Cultivar Collection

One hundred maize cultivars were obtained from the International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria. The cultivars were handpicked to obtain uniform grains and exclude broken kernel and extraneous materials.

2.2. Physical Characteristics Tests

The method of Rooney and Miller [13] was modified to carry out the physical features on the entire hundred maize cultivars. These include colour, kernel classification, number of grains per 100g dry weight of each cultivar, and endosperm-pericarp ratio. One hundred kernels were randomly selected from each of the cultivar and mass were recorded with a top loading weighing balance. The pericarp-endosperm ratio was determined after staining the longitudinal sectioned seed with iodine solution. The length of the starchy pericarp was recorded over the length of the endosperm which turns blue-black.

The modified method of Institute of Brewing [14] as reported by Awoyinka [15] was adopted to investigate the germinative properties of each of the cultivar. 250 grams of each grain was steeped to give a grain/water ratio 3:4 in a cycle comprising six hours wet and three hours dry for sixty-five hours. After the steeping regime the cereal was spread in germination boxes in the dark and made to grow for three days in an atmosphere of near water saturation at room temperature to encourage sprouting as described by Morral *et al*. [16]. Shoot length was taken with a graduated meter rule and manual counting of percentage growth of the respective maize cultivar.

2.3. Statistical Analysis

A total of nine readings collated from three successive replicated experiments at three separate periods but same laboratory conditions were analyzed for their means using Sigma Plot [17].

3. Results and Discussion.

The selected physical characteristic on all the hundred maize cultivar is shown in the **Table 1**. Generally, the maize kernel color is in two major forms namely white and yellow. From the observations recorded a total number of fifty-nine of the cultivar were pure white while seven of the cultivar was found to have dull-white coloration. Twenty-three of all the maize cultivar obtained was of deep yellow coloration while the remaining eleven were light yellow. It is a known fact that colour of kernel may contributes significantly to the overall appearance after processing [18]. This may also be a factor by which a product made from maize could be appealing and accepted for consumption by an individual.

As shown in the **Table 1** the pericarp-endosperm ratio for both Dent and Floury maize on the average ranged between 0.3/0.6 cm and 0.3/0.7 cm respectively. Except for waxy maize that has its pericarp-endosperm ratio at 0.3/0.6 cm the pericarp-endosperm ratio for both Flint and Sweet maize was found to be between 0.2/0.5 cm and 0.3/0.6 cm respectively. The pericarp-endosperm ratio is an estimation of the amount of starch present in a kernel [19].

Table 1. Physical characteristics of the maize cultivars.

Nos	Cultivars Name	Colour	Grains Classification	Pericarp/Endosperm Ratio (cm)	Number of Grain per 100 g	Shoot Length (cm)	Percent of Growth
1	Acr 20 tzl comp$_4$c$_4$	Light-yellow	Flint	0.3/0.7	387	2.1	71.7
2	Acr 89 dmr esr-w	White	Dent	0.6/0.8	376	0.9	40.8
3	Acr 94 tze comp 5-w	Dull white	Waxy	0.4/0.7	399	2.3	19.2
4	Acr 95 tze comp 4c$_3$	White	Dent	0.3/0.8	312	2.4	96
5	Acr 96 str syn-y	White	Dent	0.3/0.7	234	2.7	77.1
6	Acr 97 tze comp 3 * 4	Light-yellow	Floury	0.3/0.7	385	2.7	50.2
7	Acr 97 tze comp 4c$_3$	Yellow	Dent	0.3/0.8	394	0.8	34.6
8	Acr9449 str	White	Sweet	0.2/0.5	375	0.9	58.6
9	Advance ncre str	White	Floury	0.4/0.7	209	2.0	100
10	Aflato syn var $_1$f$_2$	White	Dent	0.4/0.7	412	0.8	46.5
11	Ak 95 dmr esr-w	White	Dent	0.3/0.8	366	0.3	24.8
12	Ak 9522 dmsr	White	Dent		336	2.7	92.4
13	Ak 96 dmr sr-w	White	Dent	0.2/0.8	240	2.3	95.8
14	Ama tzbr-wc$_2$ af$_1$	Yellow	Flint	0.3/0.7	474	1.7	78.1
15	Ama tzbr-wc$_2$af$_1$	Dull White	Waxy	0.3/0.8	256	2.4	75.3
16	Ama tzbr-y-1	White	Dent	0.2/0.7	396	3.1	76.3
17	Atp-sr	Yellow	Dent	0.4/0.8	300	2.1	65.3
18	Bdp-sr-bc5	White	Pop	0.5/0.7	304	0.4	86.8
19	Br 922 dmr sf$_2$	Yellow	Pop	0.3/0.8	178	2.7	35.5
20	Br 9943-dmsr	White	Dent	0.4/0.7	332	2.0	76.5
21	Btsr-y	Yellow	Floury	0.4/0.8	309	1.8	53.4
22	Busola str	White	Dent	0.2/0.7	290	2.6	97.9
23	Cam-1-str-1	Yellow	Dent	0.5/0.8	238	1.9	96.6
24	Dmr esr-w-1c $_1$f$_2$	White	Dent	0.4/0.7	327	3.2	98
25	Dmr esr wqpm	White	Floury	0.4/0.8	243	2.6	100
26	Dt sr-w-z	White	Waxy	0.3/0.8	218	1.1	82.6
27	Dt variety kamp. 88 pool	White	Dent	0.3/0.8	204	1.7	97.3
28	Dtsr wc$_1$f$_2$ o/c 14426	White	Waxy	0.3/0.8	350	2.1	96.8
29	Dt-sr-y-1	Yellow	Dent	0.4/0.8	218	1.8	86.3
30	Early strain	White	Floury	0.3/0.6	258	2.1	40.8
31	Early strain	White	Dent	0.4/0.7	334	2.5	76.0
32	Ev 8766 sfbc6 qpm	Yellow	Dent	0.3/0.7	476	0.9	35.6
33	Ev99 qpm	Yellow	Flint	0.2/0.5	379	2.1	83.6
34	Evdt 97 str co	White	Sweet	0.4/0.6	371	1.1	58.8
35	Fetzee-w-str	White	Dent	0.3/0.8	378	0.8	58.1
36	Heipang 97 tze comp 3*4	White	Dent	0.3/0.8	243	1.0	75
37	Icz 5bl 2a 9450f$_1$	White	Dent	0.5/0.8	456	0.7	15.7
38	K9350 str	Dull white	Floury	0.7/0.8	314	2.7	100
39	Ku 1409 str	Yellow	Dent	0.4/0.7	396	0.8	1.5
40	Lnp c$_3$-yf$_1$	Light yellow	Dent	0.4/0.6	190	1.1	96.8
41	Lnp w. Wxlntpf$_1$	White	Floury	0.4/0.6	210	2.3	100
42	Lnp wx nttpf1	White	Waxy	0.4/0.8	392	1.5	94.6
43	Lnp wxlntps1c1f1	White	Waxy	0.4/0.8	224	2.4	87.5
44	Lnpc$_2$f$_2$	White	Dent	0.4/0.7	394	2.5	82.2

Continued

45	Maka-srbc5	White	Flint	0.3/0.5	342	1.7	86.6
46	Mok pioneer white	White	Dent	0.3/0.7	386	0.2	39.4
47	Obatampa qpm	White	Dent	0.8/0.9	214	1.2	93.5
48	Pool 18-sr/ak 94 dmr/esr-	Yellow	Sweet	0.3/0.8	262	1.4	79.4
49	Pop 66 sr/tzusr-w-sgy qpm	White	Flint	0.3/0.7	240	1.9	100
50	Prol. W pool cof$_1$	Dull white	Waxy	0.4/0.8	208	1.0	100
51	Samaru inb-y-str	Yellow	Flint	0.3/0.8	274	0.1	47.7
52	Sb syn wf2	White	Dent	0.3/0.8	414	0.9	44.7
53	Spe	White	Pop	0.4/0.8	236	1.2	94.9
54	Spmat	Light-yellow	Dent	0.6/0.8	288	0.7	49.3
55	Temp. * trop. * prolific c$_1$f$_1$	Light-yellow	Dent	0.4/0.7	246	1.1	77.2
56	Tzbr-syn w/y co	Light-yellow	Floury	0.5/0.8	317	2.6	65
57	Tzbr eld$_1$c$_4$	Yellow	Floury	0.4/0.7	355	2.1	42.0
58	Tzbr eld4 co f$_1$	Light yellow	Floury	0.3/0.7	398	0.7	35.1
59	Tzbr eld4 cof$_2$	Yellow	Dent	0.2/0.7	360	2.5	85.6
60	Tzbr eld$_4$cowf$_2$	White	Flint	0.4/0.8	468	1.4	55.4
61	Tzbr ses1 c3-w	White	Pop	0.5/0.8	371	2.0	56.7
62	Tzbr ses$_3$ c$_4$ 1f$_2$	Yellow	Dent	0.3/0.7	340	1.4	60
63	Tzbr ses$_3$c$_4$f$_2$	White	Dent	0.3/0.8	340	2.6	75.3
64	Tzbr syn wf$_1$ 1/1	White	Dent	0.3/0.7	380	2.2	45.8
65	Tzbr syn-y	White	Floury	0.3/0.5	212	1.4	93.4
66	Tzbreld1 c$_8$-yf$_2$	Light yellow	Sweet	0.4/0.7		0.6	53.6
67	Tze comp3 c3	White	Dent	0.8/1.0	214	2.8	100
68	Tze comp$_3$ dt cof$_2$	Dull white	Waxy	0.6/0.9	353	0.5	50.3
69	Tze comp3*4 syn f$_2$	White	Waxy	0.3/0.4	206	1.7	84.6
70	Tze comp$_4$c$_2$	White	Sweet	0.4/0.8	318	2.8	65.2
71	Tze comp4c4 f2	White	Waxy	0.4/0.8	320	2.1	100
72	Tze y pop dt str c4	Yellow	Dent	0.2/0.7	458	2.6	73.8
73	Tzecomp$_4$c$_2$	White	Waxy	0.3/0.6	192	0.8	42.3
74	Tzecomp$_4$c$_3$	Light-yellow	Floury	0.2/0.5	456	2.3	56.7
75	Tzecomp5c$_2$f$_2$	Light yellow	Flint	0.3/0.7	414	1.8	85.2
76	Tzee w pop str c4f1	White	Dent	0.4/0.8	442	1.8	63.0
77	Tzee w srbc$_5$	White	Dent	0.3/0.8	322	3.9	100
78	Tzee * tzee-w* demarscus * tzee-w	White	Dent	0.6/0.9	268	2.6	100
79	Tzl comp 1 syn-w $_1$f$_2$	White	Floury	0.3/0.6	410	2.6	97.2
80	Tzl comp c$_2$f$_2$	White	Dent	0.3/0.7	350	0.9	57.1
81	Tzl comp c$_5$	White	Flint	0.2/0.5	276	2.1	100
82	Tzl comp$_1$ * zdiplo bc synf$_1$	White	Floury	0.4/0.7	270	0.7	32.3
83	Tzl comp4c$_1$	Dull white	Waxy	0.3/0.4	212	2.3	100
84	Tzm comp.32	White	Flint	0.3/0.6	268	0.6	94.7
85	Tzmi 205	White	Flint	0.2/0.5	262	0.8	93.6
86	Tzpb-sr-prol c$_3$f$_1$	Dull white	Waxy	0.3/0.8	226	1.0	86.7
87	Tzutsr sgy syn f$_2$	Yellow	Dent	0.3/0.8	278	3.6	100
88	Yellow syn var-f2	Yelow	Dent	0.4/0.7	336	0.8	57.8

Continued

89	Z diplo syn-1	White	Dent	0.4/0.9	277	3.5	100
90	1368 * 1393	White	Flint	0.3/0.8	232	0.5	3.5
91	1393	White	Dent	0.2/0.8	230	1.1	98.3
92	2000 syne.e. w	White	Dent	0.3/0.7	214	1.5	95
93	4001 str	Yellow	Pop	0.4/0.6	454	1.2	91.6
94	9021-18 str	White	Flint	0.3/0.9	272	1.0	98.5
95	9022-13	White	Dent	0.5/0.9	386	2.6	49.2
96	9043 dmsr	White	Dent	0.4/0.8	340	0.9	54
97	9071	White	Flint	0.6//0.8	298	3.0	82.6
98	9450 str	Yellow	Dent	0.4/0.8	290	1.3	85.5
99	98 tzee-wstr	White	Dent	0.3/0.7	276	3.8	100
100	99 tzee-y-str	Yellow	Sweet	0.3/0.6	389	2.3	70

*values are means of replicated experimental readings.

In this study Dent maize cultivar Ev8766sfbc$_6$ qpm was found to have the highest number of grains with 476 per 100 g weight closely followed was Flint Tzbreld$_1$c$_4$ with 468 per 100 g weight while Br922dmrsf$_2$ has the least number with 178 per 100 g of the grains. At third day germination the cultivar with highest shoot length was Tzeewsrbc$_5$ with the value 3.9 cm (**Figure 1**), while Samaru inb-y-str have the least shoot length with the value 0.1 cm (**Figure 2**). The determination of sprouting rates as a function of amylase content is important for an analytical prediction of diastatic power otherwise known as combined effect of α and β amylases [20] [21]. The high amylase content of barley compare to other cereal like maize confer on it high diastatic power which has made the grain the choice cereal in brewing [22].

Observation made on the type of maize in this study in terms of the type of kernel indicates that forty-eight of the cultivar was Dent. The kernels contain a hard form of starch at the sides and a soft type in the centre. The crown of the kernel consists of soft starch hence moisture loss form this area as the kernel ripens causes a slight collapse in volume resulting in a characteristics dent and generally higher yielding than other maize types. Most of the cultivated Dent maize is either white grain which is preferred as human food or yellow grain which is largely used for animal feed [3]. Fourteen percent of the cultivar was Floury their endosperm is composed entirely of soft starch which can easily be scratched with a thumbnail. Floury maize is known to be industrially processed into starch of which a considerable proportion is used for high fructose corn syrup. However, other by-products from Floury maize, such as fodder protein and vegetable oil, also have a good market [5] [23]. A total number of fourteen of the cultivar was also found to be Flint. Characteristically the kernels are round, hard and smooth with only some starch in the very centre of the grain. It is known that Flint maize is most preferred for human fermented food [24]. Five of the entire cultivars used in this study were Pop maize. Pop Corn is an extreme form of Flint maize with a hard endosperm occupying most of the kernel and a small amount of starch in the basal part of the grain. The kernels are small with thick pericarp that varies in shape from round to oblong. The crop is grown primarily for human consumption as freshly popped corn and is the basis of popcorn confections [7]. The moisture trapped in the flour starch expands upon heating and burst through the hard kernel. The ability to pop seems to be conditioned by the unique quality of the endosperm which resists the steam pressure when heated to about 170˚C [22].

A total number of thirteen cultivars showed a characteristic feature of waxy maize. Waxy maize otherwise known as ornamental maize is currently grown in the tropics in a small area in pockets where natives prefer it as a food crop. The endosperm has a dull wax-like appearance. The starch of these maize types differs chemically from common corn starch in that it lacks amylase and is made up of amylopectin [25]. The starch of waxy corn is used for food or for making adhesives such as the gums applied to stamps, envelopes, gummed tape, corrugated paper boxes, and plywood [5] [8]. However, six percent of the cultivars in this study possess the feature of Sweet maize. The grains are high in sugar content and Sweet in taste while fresh. It is also characterized by translucent, horny appearance when immature and a wrinkled condition when dry. This type of maize is known to have high cash value as a processed vegetable in industrial economies [26].

Figure 1. Tzee-w-srbc$_5$, maize cultivar showing high shoot length after the steeping regime and third day of germination.

Figure 2. Samaru inb-y-str, maize cultivar showing a low shoots length after the steeping regime and third day of germination.

4. Conclusion

The empirical data from this study have practical applications in food and allied industries in which any of the maize cultivar could be preferentially exploited to useful products for human consumptions.

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