IMPROVEMENT OF CASSAVA FOR HIGH DRY MATTER, STARCH AND LOW CYANOGENIC GLUCOSIDE CONTENT BY MUTATION INDUCTION

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Abstract

Cassava (*Manihot esculenta* Crantz) is an important food in Nigeria. One drawback in its use as a staple food is the presence of cyanogenic glucosides which on hydrolysis produce the very toxic hydrogen cyanide (HCN). To reduce the cyanogenic levels by mutation induction, three locally adopted and high yielding varieties of cassava, TMS 30572, NR 8817 and NR 84111 were irradiated with 20, 25 and 30 Gy gamma rays. There were a wide variation in HCN, dry matter and starch content of irradiated cassava plants, screened in the MV_2 propagation. Fourteen cassavavariant lines were selected for low HCN content, and 22 lines for high dry matter content. These will be further tested for yield in replicated field trials.

1. INTRODUCTION

Cassava, *Manihot esculenta* Crantz, ranks high as a major source of cheap energy food in Nigeria. According to FAO [2], during 1985 the area under cassava cultivation in Nigeria was about 2500 x 10^3 ha compared with 1550 x 10^3 ha for yams. Production figures also show that cassava cultivation is on the increase [5]. Cassava has thus become a premier crop, a position which for several decades was occupied by yams. Among the several reasons contributing to this situation is the cultural management of cassava crop which can thrive well on marginal soils where other crops invariably fail.

With the present socio-economic changes in Nigeria, the local farmers are demanding cassava lines that are high yielding, and have high dry matter and starch, but are low in HCN content. In this paper, we report the use of mutations to induce genetic changes for high dry matter and starch content and low cyanogenic traits in the locally adopted varieties.

2. MATERIALS AND METHOD

2.1. Mutation induction

Three cassava varieties, TMS 30572, NR 8817 and NR 84111 were used in the present study. During 1993/94 cropping season, batches of 250 stem-cuttings, about 10 cm long and with 5 nodes each, from each variety were irradiated with 20, 25 and 30 Gy gamma rays from a Cobalt 60 source located at the Center for Energy Research and Development, Obafemi Awolowo University, Ile-Ife, Nigeria. During the 1994/95 season, the surviving MV_1 clones were advanced to MV_2 populations using ca. 10 cuttings per plant. The MV_2 populations were screened for hydrogen cyanide, dry matter (DM) and starch content on individual plant basis.

2.2. HCN determination

The HCN content of lines was determined using methods to estimate cyanide with alkaline picrate as suggested by Almazam [1] and Williams and Edwards [7].

2.3. DM determination

Dry matter was determined by slicing 100 g samples of cassava tubers, dried to a constant weight at 80°C in an oven.

2.4. Starch Determination

Peeled cassava tubers 100 g each were macerated and passed through 15 μM pore size sieve, using tap water. The extracted starch in water was allowed to stand for 6-12 hr, after which excess water was decanted, and the starch was dried to a constant weight in an oven at 80°C.

3. RESULTS

There was a wide variation in HCN, dry matter and starch content of the screened MV_2 cassava plants to allow meaningful selection for these traits (Table I). Based on these results, 14 cassava variant lines were selected for low HCN content (Table II). Of these, 9 lines were isolated from irradiated TMS 30572, 3 from NR 8817 and 2 from NR 84111. Of the variant lines selected for high DM content, 5 were isolated from TMS 30572, one from NR 8817 and 16 from NR 84111 (Table III).

4. DISCUSSION

Cassava is an important food in Nigeria. However, a major drawback in the use of cassava is the cyanogenic glucosides which upon hydrolysis produce toxic hydrogen cyanide. Consumption of improperly processed cassava food may lead to goitre and cretinism [6] from the ingestion and accumulation of HCN in the body. Hence, selection of cassava varieties that are acyanogenic or low in cyanogenic content is important. Hahn, et al, [3] reported that low HCN content in cassava in controlled by minor recessive gene complex, which probably accounts for the wide range in HCN content of screened MV_2 cassava plant populations, and the large number of recoverable low cyanogenic variant lines, in the present study. Moh [4] reported a wide range in HCN levels of irradiated cassava cuttings when MV_1 leaves were screened for HCN levels.

Yield of cassava root tubers is related to tuber volume and dry matter content. Yield therefore can be improved by increasing dry matter content. In cassava products such as 'gari', recovery largely depends on the dry matter content of the tubers; thus it important to have high dry matter, since such food products are marketed in dry form. The results suggest that the dry matter and starch content of cassava root tubers and their cyanogenic content can be improved through mutagenesis. The isolated variant lines will be further tested for yield in field trials.

TABLE I. HCN, DRY MATTER AND STARCH CONTENT OF MV_2 POPULATIONS OF THREE CASSAVA VARIETIES

	HCN score			Dry matter content (%)			Starch content (%)		
Variety	X±S.E	Range	CV (%)	S±S.E	Range	CV (%)	X±S.E	Range	CV (%)
TMS 30572	6.2±0.13	3 - 9	23.0	32.2±0.65	14 - 42	18.8	20.3±0.32	12 - 28	16.2
NR 8817	6.6±0.16	3 - 9	21.5	24.8±0.59	10 - 40	16.9	14.1±0.70	7 - 20	32.7
NR 84111	5.0±0.15	3 - 9	32.2	34.7±0.45	20 - 35	13.4	19.9±0.26	11 - 24	13.5

TABLE II. CASSAVA MUTANT LINES SELECTED FOR LOW CYANOGENIC GLUCOSIDE CONTENT IN THE ROOT TUBERS

Mutant Line	HCN Score	HCN Content (ppm)	Dry Matter (%)	Starch Content (%)
30572/30/002(2)	4	25 - 40	31.1	19.3
30572/30/004(1)	3	15 - 25	31.2	25.0
30572/30/005(5)	4	25 - 40	30.0	20.8
30572/30/007(4)	3	15 - 25	37.0	24.1
30572/30/007(8)	3	15 - 25	34.0	19.3
30572/30/007(6)	3	15 - 25	40.0	15.0
30572/30/008(8)	3	15 - 25	33.8	22.3
30572/20/010(1)	3	15 - 25	15.4	15.2
30572/20/010(2)	4	25 - 40	32.4	12.2
30572/Control			35.0	22.2
8817/30/004(2)	3	15 - 25	34.4	21.3
8817/25/009(3)	4	25 - 40	24.5	11.6
8817/20/003(5)	3	15 - 25	28.5	13.5
8817/Control			28.0	23.6
84111/25/002(6)	2	10 - 15	34.0	20.5
84111/10/003(1)	2	10 - 15	36.3	22.3
84111/Control			36.1	21.6

TABLE III. CASSAVA LINES SELECTED FOR HIGH DRY MATTER CONTENT

Mutant Line	DM (%)	Starch Content (%)	HCN Rating
30572/30/001(6)	42.0	28.0	M
30572/30/003(3)	40.0	23.6	M
30572/30/007(7)	40.0	15.0	L
30572/25/004(3)	40.0	22.0	M
30572/25/005(3)	40.4	20.6	H
30572/Control	35.0	22.0	
8817/25/002(3)	31.9	18.3	M
8817/Control	28.0	16.3	
84111/30/008(2)	40.0	17.5	M
84111/25/001(1)	40.8	20.0	M
84111/20/001(7)	40.0	24.6	M
84111/20/003(7)	40.0	21.3	M
84111/20/006(4)	40.0	24.6	L
84111/20/006(9)	40.3	19.9	H
84111/20/007(8)	40.4	24.3	M
84111/20/009(1)	42.3	22.6	M
84111/20/009(4)	40.3	20.0	H
84111/20/010(2)	41.3	23.2	M
84111/20/010(3)	41.3	21.3	M
84111/20/011(1)	41.3	21.5	M
84111/20/011(5)	40.8	21.3	M
84111/20/011(6)	40.9	23.0	H
84111/20/011(8)	40.8	20.1	M
84111/20/011(10)	42.7	22.7	M
84111/Control	36.1	23.6	

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REFERENCES

[1] ALMAZAN, A.M. A guide to the picrate test for cyanide in cassava leaf. IITA, Ibadan Nigeria (1987) 8 pp.

[2] FAO. Production Year Book. 38 (1985), FAO, Rome.

[3] HAHN, S.K., HOWLAND, A.K., WILSON, J.E. Breeding of root and tuber crops, Proc. 1st. Nat. Seminar on root tuber crops. NRCRI, Umudike, March 21-25, (1977) 36-47.

[4] MOH, C.C. Screening for a cyanogenic somatic mutations in cassava (*Manihot esculenta* Crantz). Mutation Breed. Newsl. 8 (1976)10-11.

[5] OKIGBO, B.N. Roots and tubers in the African food crisis. Proc. 3rd Triennal Symp. Intern. Soc. Trop. Root crops - Africa Branch. Owerri, Nigeria. 17-23 August, 1986. (1987) 9-20.

[6] ROSLING, H. Cassava toxicity and food security. International Child Health Care Unit, University Hospital, Uppsala, Sweden (1987) 40 pp.

[7] WILLIAMS, H.J., EDWARDS, T.C. Estimation of cyanide with alkaline picrate. J. Sci. Food Agric. 31 (1980) 15-22.