Characterization and Evaluation of Sweet Potato Genetic Resources of West Bengal

A Chattopadhyay, H Sen, I Chakraborty[1], M Satapathy[2], LLT Prakasa Rao[2] and A Dutta[2]

All India Coordinated Research Project on Tuber Crops, Bidhan Chandra Krishi Viswavidyalaya, Directorate of Research, Kalyani, Nadia-741 235 (West Bengal)

[1]Department of Post Harvest Technology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741 252 (West Bengal)

[2]Department of Agronomy & Plant Breeding, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia-741 235 (West Bengal)

Seventy genotypes of sweet potato were collected from various sources and evaluated for morphological, agronomical and quality characters in Augmented Design during *Rabi* season of 2000-2001 under sub-humid condition of West Bengal. The descriptive terminology recommended by International Plant Genetic Resources Institute was adopted in the present study. Wide range of variations were recorded for most of the traits. Frequency percentage of genotypes for variability in each character was calculated. Majority of the genotypes had white/cream flesh whilst five had orange/pale orange colour. A close relationship between orange flesh and high carotenoid pigments as well as white flesh and high dry matter content of tuber were observed. However, none of the biochemical constituents showed any relationship with plant morphologic characters. Some of the genotypes were identified as potential genotypes for commercial production and processing.

Key Words: Characterization, Diversity, Genetic Resources, Quality, Sweet Potato

Sweet potato has the potential to contribute in agriculture because of its calorie yield, nutritive value, adaptability and asexual mode of reproduction. Genetic variation and conservation of diversity within a crop species are the basis for all varietal improvement programmes. An efficient plant breeding programme required a ready access to the useful and representative genetic resources with a clear cut definition on the identity of a variety, its relationship with other varieties in a particular collection and the amount of variation existing in that germplasm. Therefore, evaluation of the existing germplasm is needed since the cultivars are showing high level of genetic variability in leaf shape, vine and emerging leaf colour, tuber yield, root shape, skin and flesh colour of tubers, maturity period, biochemical constituents etc. An attempt has been made in the present paper to evaluate the existing germplasm of sweet potato in West Bengal for identification of genotypes with desirable plant characteristics and their use in further crop improvement programme.

Materials and Methods

Seventy genotypes of sweet potato collected from various sources were planted in an Augmented Design during *Rabi* season in 2000-2001 at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India (23.5° N Latitude; 80° E Longitude; Altitude of 9.75 m). The soil type was sandy loam in texture having pH 6.1. Each genotype was planted in three rows of 2 m each bed at a distance of 60 cm from row to row and 20 cm within the row. Recommended cultural practices were followed as scheduled for its cultivation. Five competitive plants from each genotype were tagged and data were recorded. The accessions were characterized for different morphological traits as per descriptors recommended by Huaman (1999). Agronomic parameters like length, girth, number and weight of tuber/plant were measured from marketable tubers of 120 days maturity. Dry matter of tube was determined by drying known weight of fresh samples till constant weight was achieved at 70°C. Pooled samples from five tubers of 4-month-old of each accession were used for the analysis of biochemical constituents. Starch and total sugar [(fresh weight basis (FWB)] of tubers were analysed by rapid titrimetric method as described by Moorthy and Padmaja (2000). Ascorbic acid as well as total carotenoids as expressed by β-carotene content of tuber were determined by the method of Ranganna (1977) and crude fibre was estimated by following the procedure of A.O.A.C. (1975). The frequency percentage of genotypes for each morphological, agronomical and qualitative trait was analysed.

Results and Discussion

The germplasm showed a wide range of variations for different agro-botanical and biochemical characteristics. Diversity for some of the plant morphological characters and their frequency percentage are presented

in Table 1. Root morphological characters of different germplasms are presented in Table 2. The tuber shape of the genotypes varied from round to long, irregular or curved and having some defects. The tuber arrangements of most of the germplasms were disperse except two where close clustering habit was observed. Majority of the genotypes had white/cream flesh whilst five had orange/pale orange colour.

Wide variations were observed in different agronomic traits *viz.*, length of tuber (8.1-17.5 cm), girth of tuber (2.2-7.3 cm), number of tuber/plant (2.5-8), weight of tuber/plant (62-340 g) etc. which are presented in Table 3. The evaluated germplasm were grouped into three categories (high, medium and low) based on their qualitative characteristics (Table 4). A wide diversity was observed in different biochemical constituents *viz.*, starch (7-22.50% FWB), total sugar (1.2-4.5% FWB), ascorbic acid (8-42 mg/100g), β-carotene (0.5-8 mg/100g), crude fibre (0.5-0.9% DWB) etc. The dry-matter content of tuber varied between 22% and 35%. In general, the genotype having white coloured flesh exhibited higher amount of dry matter. This finding corroborated the earlier findings of Hamilton *et al.* (1986) that higher dry matter was correlated with light flesh colour. Similarly, correlation between orange/dark cream flesh colour and high carotenoid pigments was observed and reported by several workers (Hernandez, 1963; Garcia *et al.*, 1970). A more or less similar variation for ascorbic acid and crude fibre content were observed as recorded by Kays (1992) and Babu *et al.* (1990), respectively. However, none of the biochemical constituents could be correlated with plant morphological characters of sweet potato. So, selection based on biochemical traits would be effective for identification of genotypes for commercial production and processing. The promising lines identified for different traits are detailed in Table 5.

From the above discussion, it is inferred that the collected germplasms showed a significant variation in almost all the characters studied. Some of the accessions/ indigenous cultivars (BCSP-5, BCSP-10, OP-57, RS-5, H-635, 90/704, CO-3) having high starch coupled with low sugars and crude fibre could be recommended for industrial uses for the preparation of noodles and flour. Similarly, genotypes (Kamala Sundari, 90/101, H-85/16, 90/566) recorded high β-carotene, low starch and high moisture were identified for preparations like desserts and juices etc. On the other hand, genotypes

Table 1. Diversity for different plant morphological traits of sweet potato

Character	No. of accessions	Frequency (%)
Plant type		
Erect (< 75 cm)	24	34.28
Semi-compact (75-150 cm)	41	58.57
Spreading (151-250 cm)	05	7.14
Internode length		
Very short (< 3 cm)	15	21.22
Short (3-5 cm)	44	62.85
Intermediate (6-9 cm)	10	14.28
Very long (> 12 cm)	01	1.42
Colour of vine		
Green	31	44.28
Green with few purple spots	17	24.28
Green with many purple spots	08	11.42
Mostly purple	09	12.85
Totally purple	05	7.14
Vine tip pubescence		
None	52	74.28
Sparse	13	18.57
Moderate	03	4.28
Heavy	02	2.85
General leaf outline		
Triangular	20	28.57
Hastate	18	25.71
Lobed	30	42.85
Almost divided	02	2.85
Shape of central leaf		
Teeth	04	5.71
Triangular	08	11.42
Semi circular	02	2.85
Semi elliptic	25	35.71
Elliptic	24	34.28
Lanceolate	04	5.71
Oblanceolate	01	1.42
Kinear	02	2.85
Number of leaf lobes		
01	08	11.42
03	25	35.71
05	37	52.85
Abaxial leaf vein pigmentation		
Yellow	06	8.57
Green	19	27.14
Purple spot at base of main rib	19	27.14
Purple spot in several veins	01	1.42
Main rib partially purple	03	4.28
Main rib totally purple	03	4.28
All veins partially purple	05	7.14
All veins totally purple	14	20.00
Mature leaf colour		
Yellow green	29	41.42
Green	33	47.14
Green with purple edge	03	4.28
Green with purple veins on upper surface	01	1.42
Slightly purple	01	1.42
Mostly purple	03	4.28
Petiole length		
Very short (< 10 cm)	43	61.42
Short (11-20 cm)	24	34.28
Intermediate (21-30 cm)	03	4.28
Petiole pigmentation		
Green	25	35.71
Green with purple near leaf	16	22.85
Green with purple at both ends	19	27.14
Green with purple spot throughout petiole	04	5.71
Green with purple stripes	04	5.71
Totally or mostly purple	02	2.85

Table 2. Diversity for different root morphological characters of sweet potato

Character	No. of accessions	Frequency (%)
Root skin colour		
White	02	2.85
Cream	09	12.85
Yellow	01	1.42
Orange	01	1.42
Brownish orange	02	2.85
Purple red	39	55.71
Dark purple	16	22.85
Flesh colour		
White	35	50.00
Cream	24	34.28
Pale yellow	06	8.57
Pale orange	03	4.28
Dark orange	01	1.42
Intermediate orange	02	2.85
Root shape		
Round	03	4.28
Round elliptic	07	10.00
Elliptic	23	32.85
Obovate	01	1.42
Ovate	09	12.85
Oblong	01	1.42
Long elliptic	24	34.28
Long irregular/curved	02	2.85
Root defects		
Shallow horizontal constrictions	30	42.85
Deep horizontal constrictions	10	14.28
Shallow longitudinal grooves	10	14.28
Deep longitudinal grooves	11	15.71
Deep constrictions and deep grooves	08	11.42
Veins	01	1.42
Root arrangement		
Closed cluster	02	2.85
Open cluster	10	14.18
Disperse	43	61.42
Very disperse	15	21.42

Table 3. Diversity for different agronomic characters of sweet potato

Character	No. of accessions	Frequency (%)
Length of tuber		
Long (> 12 cm)	36	51.43
Short (< 12 cm)	34	48.57
Girth of tuber		
High (> 6 cm)	18	25.71
Low (< 6 cm)	52	74.29
Number of tuber/plant		
High (> 4)	10	14.29
Low (< 4)	60	85.71
Tuber weight/plant		
High (> 250 g)	15	21.43
Low (< 250 g)	55	78.57

Table 4. Diversity for different qualitative traits of sweet potato

Character	No. of accessions	Frequency (%)
Starch (%) FWB		
High (18-22.5)	20	28.57
Medium (13-17.9)	38	54.29
Low (7-12.9)	12	17.14
Total sugar (%) FWB		
High (3.1-4.5)	12	17.14
Medium (2.1-3)	50	71.43
Low (1-2)	08	11.43
β-carotene (mg/100g)		
High (5-8)	05	7.14
Medium (2.5-4.9)	30	42.86
Low (0.5-2.4)	35	50.00
Ascorbic acid (mg/100g)		
High (30-42)	12	17.14
Medium (15-29.9)	33	61.43
Low (8-14.9)	25	21.43
Crude fibre (%) DWB		
High (0.76-0.90)	12	17.14
Medium (0.66-0.75)	38	54.29
Low (0.50-0.65)	20	28.57
Dry-matter of tuber (%)		
High (> 30%)	08	11.43
Medium (25-29.9%)	28	40.00
Low (22-24.9%)	34	48.57

Table 5. Promising lines identified in sweet potato

Character	Accessions/indigenous cultivars
Erect plant habit	90/101, 90/704. 90/566, Pol-4-4-5-, OP-57, IGSP-6, IGSP-7
Longer petiole	WBSP-4, RNSP-1
Totally pigmented vine	H-85/16, S-30, X-180-2, Tripty, WBSP-4
Longer tuber	H-620, H-85/16, -635, X-5, IB-81, OP-219, OP-217, BCSP-10, BCSP-4, IGSP-9, IGSP-8, NDSP-9, IBM-96-229, WBSP-4
Higher girth of tuber	X-100-2, 90/101, X-38, H-85/16, BCSP-6, BCSP-9, BCSP-10, Sree Bhadra, S-1121, Tripty, Kamala Sundari, WBSP-4, IGSP-8
Higher weight of tuber/plant	BCSP-10, S-1221, Tripty, Kamala Sundari, WBSP-4, IGSP-8, BCSP-5, BCSP-7, 90/101, 90/704
Orange fleshed tuber	Kamala Sundari, H-42, 90/101, H-85/16, 90/566
High starch content	H-635, S-783, BCSP-10, X-5, 90/704, H-268, RS-5
High sugar content	H-268, BCSP-3, Sree Vardhini, BCSP-2, 90/101, Kamala Sundari, Tripty, S-1221
Low sugar content	BCSP-5, OP-21, 84-X-1, CO-3, H-635, BCSP-10, IBM-95-229
High β-carotene content	Kamala Sundari, H-85/16, H-42, 90/101, 90/566, S-1221, C—3, Tripty, 90/704, H-268, X-110-2
High ascorbic acid content	9-/704, Tripty, X-110-2, H-85/16, BCSP-5, S-1221, CO-3, H-268, Kamala Sundari, 90/101
Low crude fibre content	90/704, Rs-5, H-85/16, BCSP-10, OP-57, 90/101, Kamala Sundari, H-635, BCSP-5, CO-3
High dry matter content	S-72, OP-57, H-635, H-268, X-5, RS-5, BCSP-5, BCSP-10, OP-21

(90/704m S-1221, Kamala Sundari, H-268, 90/101, X-110-2, Tripty) having high sugars, ascorbic acid, carotene content coupled with high yield are most suited for commercial production for consumption purpose on account of their high nutritive value.

References

AOAC (1975) Official Methods of Analysis, Crude fibre, Horowitz, W (ed) 12th ed. Washington DC. 136p.

Babu L (2000) Biochemical composition and nutritive value of sweet potato. *Proceedings of Fourth International Training Course on Integrated Production and Processing Technologies for sweet potato,* Central Tuber Crops Research Institute, Trivandrum, India, pp 125-33.

Babu L, B Nambisan and S Sundaresan (1990) Comparative evaluation of bio-chemical constituents of selected tuber crops. *J. Root Crops ISRC Nat. Sym. Special* pp 270-273.

Garcia EH, IB Querido and AC Cahanap (1970) The relation of carotene and starch content of some twenty-six varieties of sweet potatoes. *Philippines J. Plant Industry* **35:** 203-13.

Hamilton MG, A Jones, PD Dukes and JM Schalk (1986) Selection criteria for breeding sweet potatoes for industrial uses. *Hort. Sci.* **22:** 1426-28.

Hernandez TP (1963) A study of the inheritance of skin colour, total carotenoid pigments, dry-matter and techniques in classifying these characters in *Ipomoea batatas. Diss. Abstr.* **24:** 2210-11.

Huaman Z (1999) Morphologic identification of duplicates in collection of *Ipomoea batatas. In:* Huaman Z (ed) *Sweet potato Germplasm Management Training Manual,* International Potato Centre (CIP), Lima, Peru, Section 1-3.

Kays SJ (1992) The chemical composition of sweetpotato. *In:* Hill WA, CK Bonsi and PA Loxtaan (eds) *Sweet potato Technology for the 21st Century Proceedings of Symposium 1991,* Tuskegee University, Tuskegee, Alabama.

Moorthy SN and G Padmaja (2000) A rapid titrimetric method for determination of starch in tuber crops. *J. Root Crops* (In press).

Ranganna S (1977) *Manual of Analysis of Fruits and Vegetable Products.* Tata McGraw Hill Publishing Co. Ltd., New Delhi.