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Assessment of nutritional composition in elephant foot yam (*Amorphophallus paeoniifolius* Dennst- Nicolson) cultivars

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Abstract

Elephant foot yams make a significant contribution to diets in tribal people of India. However, there is insufficient study of their nutritional and antioxidant value. In this paper the various traits of eleven cultivars of elephant foot yam: BCA-1, BCA-2, BCA-4, BCA-5, BCA-6, NDA-4, NDA-5, NDA-9, IGAM-1, AC-28 and Gajendra were studied and observed during the growth and development stage. The cultivar of BCA-6 contained the maximum amount of starch and total phenol at 100 Days After Planting (DAP) while cv., NDA-9 and NDA-5 showed the maximum content of starch and total phenol at 250 DAP respectively. However, the cultivar BCA-1 stored the maximum amount of carbohydrate at 100 DAP whereas ascorbic acid and β-carotene content was highest at 250 DAP. The protein amount was maximum in cv., BCA-2 and AC-28 at 100 and 250 DAP respectively. This information will provide breeders with the ability to develop desirable types of elephant foot yams having high yields and better nutritional profiles.

Keywords: *Amorphophallus paeoniifolius*; Cultivar; Composition; Antioxidant; Quality

1 Introduction

Elephant foot yam (*Amorphophallus paeoniifolius* Dennst-Nicolson) is locally used as a staple food in many Asian countries (Jansen, Wilk, & Hetterscheid, 1996) and contributes both as tuber crops and vegetables to the diets of tribal people of India, particularly in rural areas where they are freely available. Among tropical aroid tuber crops, elephant foot yam has become popular due to high productivity in a short growing season and high net returns of 2103.7 to2629.6/ha. It contains vitamins, minerals, and energy (Bradbury & Holloway, 1988; Chowdhury & Hussain, 1979; Parkinson, 1984; Sakai, 1983) and has medicinal and therapeutic value (Chattopadhyay & Nath, 2007). Elephant foot yam has some useful health benefits such as the root is carminative, restorative, stomachic and a tonic. It is dried and used in the treatment of piles and dysentery, where the fresh root acts as an acrid stimulant and expectorant. It is much used in our country in the treatment of acute rheumatism. It is basically a crop of South Eastern Asian origin and serves as a source of protein as well as starch. It has long been used as a local staple food in many countries such as the Philippines, Java, Indonesia, Sumatra, Malaysia, Bangladesh, India, China and South Eastern Asian countries (Chandra, 1984; Sugiyama & Santosa, 2008). In India, it is cultivated in Andhra Pradesh, West Bengal, Gujarat, Kerala, Tamil Nadu, Maharashtra, Uttar Pradesh, and Jharkhand whereas in northern and eastern states, wild and local cultivars are

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Nomenclature

AC	*Amorphophallus Companulatus*
BCA	*Bidhan Chandra Amorphophallus*
C	Cultivar
CD	Critical difference
DAP	Days after planting
IGAM	*Indira Gandhi Amorphophallus*
NDA	*Narendra Dev Amorphophallus*
S Ed	Standard Error of Deviation
Y	Year

grown and generally used for making vegetable pickles and medicine preparations for various ailments (Ravi, Ravindran, & Suja, 2009). It is an important member of the family Araceae and is gaining importance in tropical countries, not only as a food security crop but also as a cash crop due to its production potential and popularity as a starchy vegetable having high nutritive and medicinal values (O'Hair & Asokan, 1986). Elephant foot yam along with other tropical arid tuber crops has now become an obvious candidate as a food security crop because of its capacity to do well on marginal soils even with low annual rainfall and its ability to give some return even in the years of droughts and flood (Mitra & Tarafdar, 2008). Elephant foot yam also offers export potential since it is not commercially cultivated in other countries (Misra & Shivlingaswamy, 1999; Misra, Shivlingaswamy, & Maheshwari, 2001). The corms are usually eaten as a vegetable after boiling or baking and are rich in calcium (50 mg/g), phosphorus (34 mg/g) and vitamin A (260 IU/g). The leaves are used as a vegetable by local tribes in India because they contain high concentrations of vitamin A (Rajyalakshmi et al., 2001).

Elephant foot yam is considered to be a healthy low-fat food and is a rich source of essential fatty acids (Omega-3 fatty acids), which are known to increase the good anti cholesterol levels in the blood. Eating elephant foot yam consumption can increase the estrogen levels in women's bodies, thus helping to maintain the hormonal balance. It is also high in vitamin B-6, which provides relief from pre-menstrual syndrome in women. It is a natural product that is high in fiber. It can be used as slimming food because it lowers cholesterol levels and promotes weight loss and also has a high concentration of key minerals. People who are traditionally dependent on consumption of starch-rich foods may be unaware of the nutritive value of new high yielding varieties of elephant foot yam. Thus, along with the aim of increasing productivity of elephant foot yam, in this study, an attempt has also been made to reduce the acridity of the corms by selecting non-acrid cultivars, as well as nutritional importance and adopting suitable measures for making this crop more remunerative and popular. Consumers of elephant foot yam often select varieties having the best flavor, texture, and color rather than those having a better nutrient profile. Systemic morphological, horticultural and nutritional characterization for cultivars of elephant foot yam is lacking (Saikia & Borah, 1994; Singh, Awasthi, & Singh, 1999). The results of the qualitative evaluation of this crop by Chowdhury and Hussain (1979); Sakai (1983), Bradbury and Holloway (1988); and Santosa et al. (2002) were based mainly on the analyses of very few cultivars. For this study, elephant foot yam cultivars were evaluated for horticultural and nutritional parameters and antioxidant factors, to provide information to the breeders to develop desirable cultivars having a high yield and a better nutritional profile.

2 Materials and Methods

2.1 Collection of samples

Eleven cultivars of elephant foot yam having smooth and glabrous pseudo-stems, collected from the State Agricultural Universities and Research Institutes under the Indian Council of Agricultural Research, India (Table 1), were evaluated at the research field of the All India Coordinated Research Project on Tuber Crops, Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India, from 2010 to 2012. The soil was a slightly acidic (pH 6.5) with sandy loam. The climate of the region is tropical humid with rainfall of 0.00 to 264.00 mm, temperature maximum 37.59 °C and minimum 9.62 °C along with RH (%) 96.87 to 36.74 (Annual average) by *AICRP on Agricultural Meteorology*, BCKV, Kalyani, Nadia West Bengal.

2.2 Physico-chemical analysis

The physic-chemical traits of elephant foot yam were recorded from 10 randomly selected plants for each replication throughout the year at monthly intervals during growth and development by the following methods *viz.*, starch by titration method (Moorthy & Padmaja, 2002), ascorbic acid by (2, 6-dichlorophenol indophenols- Dye) titration method, β-carotene analyzed with the help of ELICO Bio-spectrophotometer at 452 nm (Ranganna, 1986) and carbohydrate at 630 nm (Thimmaiah, 2006), protein was estimated by Lowry's method (Lowry, Rosebrough, Farr, & Randall, 1951) and total phenol was estimated by ELICO Bio-spectrophotometer (Swain & Hillis, 1959; Walter, Purcell, & Mccollum, 1979).

2.3 Statistical procedure

All the lab data arose from a Completely Randomized Design (CRD) as suggested by Raghuramula, Madhavan, and Sundaram (1983). The critical difference (CD) value at 5% level of probability was used for comparing the treatments and to find out the significant difference between them. Each treatment was replicated three times. The data was analyzed using statistical software from AGRES version 3.01 (Data Entry Module for AgRes Statistical Software© 1994 Pascal Intl software solution).

3 Results and Discussion

From the statistical analysis of the results obtained, it could be concluded that the independent variable year (Y) affected starch, carbohydrate, ascorbic acid, protein, β-carotene and total phenol content of the crop. The interaction between year and cultivar (CY) affected both crop growth and development and Table 1 showed that all cultivars were collected from different places and smooth pseudostem type.

3.1 Variation of starch, carbohydrate and protein content in elephant foot yam cultivars

Physico-chemical composition of crop varied with cultivars and it was noticed that the starch and carbohydrate were found an in increasing trend during the growth and development stage. The lowest values of starch were found in cv., NDA-4 and IGAM-1 at 100 and 250 DAP, respectively. While, the highest starch values were observed in cv., BCA-6 and NDA-9 at 100 and 250 DAP, respectively (Table 2). The range of starch content found in this experiment (4.21 % to 20.69 %) was compared to observations of Bradbury and Holloway (1988). The carbohydrate contents of elephant foot yam ranged from 16.7-75.13 mg/100g during different stages. The lowest carbohydrate content was found in cv., IGAM-1 at both 100 DAP (16.7 mg/100g) and 250 DAP (61.77 mg/100g) while, cv., BCA-1 was found highest (47.46 mg/100g) at 100 DAP and cv., BCA-5 (75.13 mg/100g) at 250 DAP (Table 3). These results were consistent with the results of a study by Gopalan, Rama-Sastri, and Bala Subramanian (1989) in elephant foot yam corm. The protein content was lowest in cv., NDA-9 at 100 DAP (3.79 %) and BCA-6 at 250 DAP (1.17 %). The highest content of protein was for cv.,

Table 1: Source and plant type of elephant foot yam cultivars

Cultivar	Source of cultivar in India	Pseudostem type
BCA-1	BCKV, Kalyani, West Bengal	Smooth
BCA-2	BCKV, Kalyani, West Bengal	Smooth
BCA-4	BCKV, Kalyani, West Bengal	Smooth
BCA-5	BCKV, Kalyani, West Bengal	Smooth
BCA-6	BCKV, Kalyani, West Bengal	Smooth
NDA-4	NDUAT, Faizabad, Uttar Pradesh	Smooth
NDA-5	NDUAT, Faizabad, Uttar Pradesh	Smooth
NDA-9	NDUAT, Faizabad, Uttar Pradesh	Smooth
AC-28	ANGRAU, Rajendranagar, Hyderabad	Smooth
IGAM-1	IGKV, Raipur, Chhattisgarh	Smooth
Gajendra	ANGRAU, Rajendranagar, Hyderabad	Smooth

BCKV- Bidhan Chandra Krishi Viswavidyalaya; NDUAT- Narendra Dev University of Agriculture and Technology; ANGRAU- Acharya NG Ranga Rao Agricultural University; IGKV- Indira Gandhi Krishi Viswavidyalaya

BCA-2 at (5.44 %) 100 DAP and AC-28 (1.86 %) at 250 DAP (Table 4). The decrease in protein content during growth and development might be due to the denaturation of protein caused by heat in the presence of moisture. Singh et al. (1999) also reported the variation in respect to moisture, protein, starch, carbohydrate, sugar and ascorbic acid within the cultivars of elephant foot yam during growth and development.

3.2 Antioxidant compounds

Antioxidant compounds in elephant foot yam varied with cultivar and year, and it was depicted that the ascorbic acid showed a decreasing trend during the growth and development phase while, β-carotene and total phenol showed an increasing trend. The ascorbic acid content was lowest in cv., IGAM-1 at 100 DAP and NDA-5 at 250 DAP. The highest amount of ascorbic acid was noticed in cv., BCA-5 at 100 DAP (10.95 mg/100g) and BCA-1 at 250 DAP (3.09 mg/100g) (Table 5). The higher ascorbic acid content at the initial stage of harvest might be attributed to an adequate supply of hexose sugar via photosynthetic activity and the reduction in ascorbic acid at the later stages might be related to an enzymatic loss of ascorbic acid through oxidation as indicated by Mapson (1970). The β-carotene content was lowest in cv., Gajendra (83.43 μg/100g) at 100 DAP and BCA-6 (210.82 μg/100g) at 250 DAP. The highest amount of β-carotene was in cv., IGAM-1 (169.03 μg/100g) at 100 DAP and BAC-1 (338.13 μg/100g) at 250 DAP (Table 6). The range of β-carotene content found in this experiment (83.43 to 338.13 μg/100g) was in line with the results observed by Onwueme (1978). The reports on the total phenol composition of elephant foot yam are limited. However, total phenol content was lowest in cv., NDA-4 (42.87 mg/100g) at 100 DAP and BCA-1 (45.79 mg/100g) at 250 DAP. The highest amount of total phenol was for cv., BCA-6 (46.74 mg/100g) at 100 DAP and NDA-5 (54.55 mg/100g) at 250 DAP (Table 7).

4 Conclusions

The analyzed elephant foot yam corms contained more starch, carbohydrate, ascorbic acid, protein, β-carotene and total phenol. These and other cultivars can be used to improve yield of this crop in West Bengal, Uttar Pradesh, Hyderabad and Chhattisgarh and other environments. It can be concluded that cultivars such as BCA-1, IGAM-1, BCA-5 and AC-28, having good nutritional value, antioxidant properties and suitability to be transformed into processed products like dried cubes, fried cubes and pickle, can be selected for further improvement and can be promoted for cultivation. These results suggest that this less familiar vegetable should not be

Table 2: Changes in starch content (%) in elephant foot yam corms during growth and development

Cv.,\DAP	100			130			160			190			220			250		
	2011-12	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**
BCA-1	9.45	6.89	8.17	10.84	7.41	9.12	11.34	9.82	10.58	15.07	13.94	14.51	18.16	15.46	16.81	18.46	16.06	17.26
BCA-2	7.87	4.56	6.21	9.62	6.34	7.98	9.87	8.67	9.27	14.70	12.38	12.38	15.42	16.83	16.13	15.66	17.96	16.81
BCA-4	5.63	9.88	7.75	7.29	10.59	8.94	9.30	12.59	10.95	12.29	13.25	12.77	12.97	15.95	14.46	14.22	16.22	15.22
BCA-5	7.46	4.56	6.01	8.76	5.71	7.24	10.21	8.57	9.39	14.81	12.04	13.43	15.75	16.34	16.05	15.87	17.07	16.47
BCA-6	8.32	9.88	9.10	8.95	10.45	9.70	9.76	12.91	11.34	12.39	15.45	13.92	14.27	16.12	15.19	15.37	17.17	16.27
NDA-4	3.85	4.56	4.21	7.85	10.17	9.01	8.98	10.63	9.80	13.24	15.12	14.18	14.23	17.85	16.04	15.18	18.18	16.68
NDA-5	4.61	7.88	6.24	6.86	10.09	8.47	8.59	10.44	9.52	12.75	14.29	13.52	14.15	17.04	15.59	15.57	17.47	16.52
NDA-9	9.17	4.56	6.86	10.63	7.11	8.87	10.89	13.19	12.04	16.04	19.59	17.81	18.78	21.95	20.37	19.25	22.12	20.69
AC-28	6.17	9.33	7.75	6.99	9.53	8.26	8.83	11.36	10.09	12.71	15.05	13.88	14.02	16.86	15.44	14.85	17.25	16.05
IGAM-1	7.69	9.88	8.78	8.10	10.32	9.21	9.21	11.43	10.32	11.73	14.05	11.73	12.66	15.67	14.16	13.69	16.69	15.19
Gajendra	5.04	7.64	6.34	8.38	10.46	9.42	9.82	11.14	10.48	11.47	14.19	12.83	15.54	14.73	15.13	17.25	14.95	16.10
Mean	6.84	7.24	7.04	8.57	8.93	8.75	9.71	10.98	10.34	13.38	14.49	13.72	15.09	16.80	15.94	15.95	17.38	16.61
	CD 0.05	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**	
C	1.910	0.947	**	1.730	0.858	NS	1.980	0.983	NS	1.935	0.960	*	1.818	0.902	**	1.994	0.989	**
Y	0.814	0.404	NS	0.737	0.366	NS	0.844	0.419	**	0.825	0.409	*	0.775	0.385	**	0.850	0.422	**
CY	2.701	1.340	**	2.446	1.213	**	2.801	1.390	NS	2.736	1.358	NS	2.571	1.275	NS	2.820	1.399	NS

C-Cv.- Cultivar; Y-Year; CD- Critical Difference at 5%; S Ed- Standard Error of Deviation; DAP- Days After Planting; R- Replication (3) ; NS- Non Significant; **- Highly Significant; *- Significant

Table 3: Changes in carbohydrate content (mg/100g) in elephant foot yam corms during growth and development

Cv.,\DAP	100			130			160			190			220			250		
	2011-12	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**
BCA-1	42.460	52.460	47.460	50.200	54.400	52.300	52.200	56.400	54.300	61.821	63.640	62.731	67.821	69.640	68.731	71.821	73.640	72.731
BCA-2	47.400	43.400	45.400	51.060	47.860	49.460	55.060	51.860	53.460	58.400	55.860	57.130	63.840	59.860	61.850	73.840	65.986	69.913
BCA-4	32.920	34.920	33.920	35.916	42.700	39.308	39.916	46.700	43.308	44.520	50.700	47.610	54.520	65.070	59.795	63.652	70.700	67.176
BCA-5	44.300	46.300	45.300	47.400	54.400	50.900	51.400	56.400	53.900	58.700	63.640	61.170	65.870	69.640	67.755	73.870	76.400	75.135
BCA-6	29.300	33.000	31.150	33.470	39.470	36.470	37.470	39.470	38.470	49.864	59.470	54.667	57.864	65.947	61.906	65.786	75.947	70.867
NDA-4	31.400	29.400	30.400	34.480	31.400	32.940	37.248	43.940	40.594	52.600	59.400	56.000	58.600	67.940	63.270	67.860	69.940	68.900
NDA-5	19.980	24.380	22.180	23.551	35.514	29.533	35.551	39.514	37.533	51.100	43.951	47.526	60.511	59.514	60.013	64.511	65.951	65.231
NDA-9	22.760	17.600	20.180	27.429	23.400	25.414	31.429	29.400	30.414	38.156	42.940	40.548	43.816	52.940	48.378	51.816	58.940	55.378
AC-28	21.660	23.960	22.810	23.420	25.340	24.380	29.420	33.340	31.380	42.960	47.334	45.147	52.960	59.334	56.147	65.296	67.933	66.615
IGAM-1	15.940	17.460	16.700	21.280	23.080	22.180	31.280	34.800	33.040	39.540	43.480	41.510	47.954	53.480	50.717	59.540	63.948	61.744
Gajendra	19.880	17.880	18.880	23.568	25.684	24.626	35.684	38.840	37.262	45.960	47.884	46.922	59.600	58.388	58.994	65.960	69.839	67.899
Mean	29.818	30.978	30.398	33.798	36.659	35.228	39.696	42.788	41.242	49.420	52.573	50.996	57.578	61.978	59.778	65.814	69.020	67.417
	CD 0.05	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**	
C	12.937	6.419	**	14.292	7.091	**	12.524	6.214	*	16.516	8.195	NS	10.730	5.324	NS	9.525	4.726	NS
Y	5.516	2.737	NS	6.094	3.024	NS	5.340	2.649	NS	7.042	3.494	NS	4.575	2.270	NS	4.061	2.015	NS
CY	18.295	9.078	NS	20.212	10.029	NS	17.712	8.788	NS	23.357	11.589	NS	15.174	7.529	NS	13.470	6.684	NS

C-Cv.- Cultivar; Y-Year; CD- Critical Difference at 5% and 1%; S Ed- Standard Error of Deviation; DAP- Days After Planting; R- Replication (3) ; NS- Non Significant; **- Highly Significant; *- Significant

Table 4: Changes in protein content (%) in elephant foot yam corms during growth and development

Cv.,\DAP	100			130			160			190			220			250		
	2011-12	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**
BCA-1	8.45	7.48	7.97	6.36	5.38	5.87	5.25	4.45	4.85	3.74	4.50	4.12	3.29	4.01	3.65	2.63	3.54	3.09
BCA-2	7.87	9.03	8.45	5.55	6.83	6.19	3.82	4.52	4.17	2.49	5.44	3.97	2.14	3.86	3.00	1.96	3.33	2.65
BCA-4	6.97	8.97	7.97	5.95	6.82	6.39	4.25	5.73	4.99	3.11	5.63	4.37	3.04	5.23	4.14	2.23	2.92	2.57
BCA-5	11.95	9.95	10.95	8.78	7.85	8.32	6.85	6.76	6.81	2.81	3.75	3.28	2.34	3.15	2.74	1.95	2.85	2.40
BCA-6	8.32	9.55	8.93	7.09	7.09	7.09	6.00	4.77	5.38	4.81	4.19	4.50	2.85	3.25	3.05	2.23	2.95	2.59
NDA-4	7.85	8.13	7.99	4.46	5.22	4.84	2.95	4.90	3.92	2.22	4.23	3.23	1.95	3.01	2.48	1.85	2.84	2.35
NDA-5	6.61	8.09	7.35	2.99	5.87	4.43	2.32	4.28	3.30	3.18	1.94	2.56	1.88	2.75	2.31	1.71	2.49	2.10
NDA-9	9.17	8.77	8.97	6.73	4.35	5.54	5.58	3.07	4.33	4.25	2.75	3.50	3.21	2.55	2.88	3.17	2.21	2.69
AC-28	8.26	10.26	9.26	4.84	5.87	5.36	3.46	4.52	3.99	2.34	3.25	2.80	2.24	3.05	2.65	1.99	2.83	2.41
IGAM-1	7.69	5.42	6.56	5.28	3.70	4.49	3.87	3.12	3.50	2.49	4.06	3.28	1.95	3.85	2.90	1.78	2.92	2.35
Gajendra	6.04	9.32	7.68	4.81	6.22	5.51	3.74	4.69	4.21	4.22	2.94	3.58	4.05	2.80	3.43	3.37	2.49	2.93
Mean	8.11	8.63	8.37	5.71	5.93	5.82	4.37	4.62	4.49	3.24	3.88	3.56	2.63	3.41	3.02	2.26	2.85	2.56
	CD 0.05	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**	
C	2.137	1.060	NS	1.883	0.934	*	2.169	1.076	NS	1.675	0.831	NS	1.753	0.870	NS	1.730	0.858	NS
Y	0.911	0.452	NS	0.803	0.398	NS	0.925	0.459	NS	0.714	0.354	NS	0.748	0.371	NS	0.737	0.366	NS
CY	3.022	1.499	NS	2.663	1.321	NS	3.067	1.522	NS	2.368	1.175	NS	2.480	1.230	NS	2.446	1.214	NS

C-Cv.- Cultivar; Y-Year; CD- Critical Difference at 5% and 1%; S Ed- Standard Error of Deviation; DAP- Days After Planting; R- Replication (3); NS- Non Significant; **- Highly Significant; *- Significant

Table 5: Changes in ascorbic acid content (mg/100g) in elephant foot yam corms during growth and development

Cv.,\DAP	100			130			160			190			220			250		
	2011-12	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**
BCA-1	8.45	7.48	7.97	6.36	5.38	5.87	5.25	4.45	4.85	3.74	4.50	4.12	3.29	4.01	3.65	2.63	3.54	3.09
BCA-2	7.87	9.03	8.45	5.55	6.83	6.19	3.82	4.52	4.17	2.49	5.44	3.97	2.14	3.86	3.00	1.96	3.33	2.65
BCA-4	6.97	8.97	7.97	5.95	6.82	6.39	4.25	5.73	4.99	3.11	5.63	4.37	3.04	5.23	4.14	2.23	2.92	2.57
BCA-5	11.95	9.95	10.95	8.78	7.85	8.32	6.85	6.76	6.81	2.81	3.75	3.28	2.34	3.15	2.74	1.95	2.85	2.40
BCA-6	8.32	9.55	8.93	7.09	7.09	7.09	6.00	4.77	5.38	4.81	4.19	4.50	2.85	3.25	3.05	2.23	2.95	2.59
NDA-4	7.85	8.13	7.99	4.46	5.22	4.84	2.95	4.90	3.92	2.22	4.23	3.23	1.95	3.01	2.48	1.85	2.84	2.35
NDA-5	6.61	8.09	7.35	2.99	5.87	4.43	2.32	4.28	3.30	3.18	1.94	2.56	1.88	2.75	2.31	1.71	2.49	2.10
NDA-9	9.17	8.77	8.97	6.73	4.35	5.54	5.58	3.07	4.33	4.25	2.75	3.50	3.21	2.55	2.88	3.17	2.21	2.69
AC-28	8.26	10.26	9.26	4.84	5.87	5.36	3.46	4.52	3.99	2.34	3.25	2.80	2.24	3.05	2.65	1.99	2.83	2.41
IGAM-1	7.69	5.42	6.56	5.28	3.70	4.49	3.87	3.12	3.50	2.49	4.06	3.28	1.95	3.85	2.90	1.78	2.92	2.35
Gajendra	6.04	9.32	7.68	4.81	6.22	5.51	3.74	4.69	4.21	4.22	2.94	3.58	4.05	2.80	3.43	3.37	2.49	2.93
Mean	8.11	8.63	8.37	5.71	5.93	5.82	4.37	4.62	4.49	3.24	3.88	3.56	2.63	3.41	3.02	2.26	2.85	2.56
	CD 0.05	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**	
C	2.137	1.060	NS	1.883	0.934	*	2.169	1.076	NS	1.675	0.831	NS	1.753	0.870	NS	1.730	0.858	NS
Y	0.911	0.452	NS	0.803	0.398	NS	0.925	0.459	NS	0.714	0.354	NS	0.748	0.371	NS	0.737	0.366	NS
CY	3.022	1.499	NS	2.663	1.321	NS	3.067	1.522	NS	2.368	1.175	NS	2.480	1.230	NS	2.446	1.214	NS

C-Cv.- Cultivar; Y-Year; CD- Critical Difference at 5%; S Ed- Standard Error of Deviation; DAP- Days After Planting; R- Replication (3) ; NS- Non Significant; **- Highly Significant; *- Significant

Table 6: Changes in β-carotene content (μg/100g) in elephant foot yam corms during growth and development

Cv.,\DAP		**100**			**130**			**160**			**190**			**220**			**250**	
	2011-12	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**
BCA-1	167.150	155.650	161.400	171.920	183.500	177.71	258.370	268.200	263.285	289.390	303.450	296.420	327.250	336.340	331.795	330.250	346.000	338.13
BCA-2	134.403	111.800	123.102	142.094	121.400	131.75	219.980	201.230	210.605	264.670	259.890	262.280	297.340	288.980	293.160	315.600	310.400	313.00
BCA-4	122.320	133.450	127.885	133.800	143.500	138.65	223.370	233.670	228.520	245.690	267.120	256.405	282.320	316.760	299.540	299.850	322.300	311.08
BCA-5	122.576	139.100	130.838	135.371	141.230	138.30	215.650	218.980	217.315	249.890	264.890	257.390	301.230	329.980	315.605	311.650	342.400	327.03
BCA-6	87.699	99.320	93.510	123.744	132.950	128.35	158.230	167.780	163.005	190.110	169.230	179.670	213.780	186.450	200.115	221.230	200.400	210.82
NDA-4	117.477	121.650	119.564	223.600	216.600	220.10	244.340	237.320	240.830	254.340	246.330	250.335	270.870	266.770	268.820	285.450	279.900	282.68
NDA-5	86.428	95.400	90.914	116.579	123.400	119.99	184.110	178.890	181.500	210.120	197.730	203.925	243.340	230.390	236.865	255.530	243.200	249.37
NDA-9	113.032	96.600	104.816	128.684	122.600	125.64	215.980	214.250	215.115	267.980	279.230	273.605	313.450	337.890	325.670	322.450	350.900	336.68
AC-28	116.563	119.700	118.132	130.939	141.200	136.07	217.230	227.350	222.290	276.230	291.670	283.950	309.120	344.450	326.785	315.750	355.300	335.53
IGAM-1	172.320	165.740	169.030	181.202	176.300	178.75	255.050	245.980	250.515	281.340	275.670	278.505	306.670	298.890	302.780	318.540	310.400	314.47
Gajendra	87.156	79.700	83.428	122.572	118.300	120.44	203.380	198.110	200.745	255.630	243.770	249.700	266.780	273.770	270.275	275.770	286.500	281.14
Mean	120.648	119.828	120.238	146.410	147.362	146.886	217.790	217.433	217.611	253.217	254.453	253.217	282.810	292.450	287.630	296.950	304.336	300.643
	CD 0.05	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**	
C	14.430	7.160	**	14.698	7.293	**	13.702	6.798	**	16.093	7.985	**	13.983	6.938	**	11.963	5.936	**
Y	6.153	3.053	NS	6.267	3.109	NS	5.842	2.899	NS	6.862	3.405	NS	5.962	2.958	*	5.101	2.531	**
CY	20.407	10.126	NS	20.786	10.314	NS	19.378	9.615	NS	22.760	11.293	NS	19.775	9.812	**	16.918	8.395	**

C-Cv.- Cultivar; Y-Year, CD- Critical Difference at 5%; S Ed- Standard Error of Deviation; DAP- Days After Planting; R- Replication (3); NS- Non Significant; **- Highly Significant; *- Significant

Table 7: Changes in total phenol content (mg/100g) in elephant foot yam corms during growth and development

Cv.\DAP	100			130			160			190			220			250		
	2011-12	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**
BCA-1	45.391	45.072	45.232	74.805	81.400	78.103	58.025	61.490	59.758	49.070	50.010	49.540	45.201	47.891	46.546	44.465	47.113	45.789
BCA-2	47.658	43.566	45.612	83.670	74.610	79.140	62.500	60.085	61.293	51.042	49.470	49.470	44.918	48.776	46.847	44.114	48.325	46.220
BCA-4	42.234	48.660	45.447	73.430	77.330	75.380	59.825	70.850	65.338	59.410	50.676	55.043	55.978	47.821	51.900	55.229	47.441	51.335
BCA-5	42.570	45.921	44.246	81.550	80.820	81.185	66.450	56.895	61.673	61.430	51.147	56.289	59.342	48.112	53.727	58.765	47.789	53.277
BCA-6	45.878	47.604	46.741	84.350	74.575	79.463	70.460	63.835	67.148	54.860	51.081	52.971	51.772	50.074	50.923	51.205	49.347	50.276
NDA-4	39.883	45.852	42.868	78.430	75.530	76.980	65.810	60.150	62.980	58.310	49.721	54.016	56.662	49.125	52.894	48.679	48.795	48.737
NDA-5	45.787	46.572	46.180	82.600	76.110	79.355	70.070	59.705	64.888	62.720	50.895	56.808	61.115	48.453	54.784	60.995	48.115	54.555
NDA-9	44.484	45.018	44.751	83.670	76.280	79.975	66.020	60.100	63.060	61.490	49.419	55.455	60.512	48.015	54.264	60.124	47.784	53.954
AC-28	44.619	43.842	44.231	75.820	84.230	80.025	64.550	59.525	62.038	58.590	50.721	54.656	56.875	50.003	53.439	56.265	48.678	52.472
IGAM-1	47.205	44.616	45.911	82.320	76.940	79.630	54.370	60.435	57.403	47.020	50.676	48.848	45.345	49.005	47.175	45.056	48.613	46.835
Gajendra	40.521	45.279	42.900	84.750	75.370	80.060	61.400	59.350	60.375	59.550	49.186	54.368	57.743	50.035	53.889	57.135	49.773	53.454
Mean	44.203	45.637	44.920	80.490	77.563	79.027	63.589	61.129	62.359	56.681	50.273	53.406	54.133	48.846	51.490	52.912	48.343	50.628
	CD 0.05	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**		**CD 0.05**	**S Ed**	
C	12.355	6.130	NS	11.031	5.473	NS	13.159	6.530	NS	1.677	5.794	NS	11.352	5.633	NS	12.495	6.199	NS
Y	5.268	2.614	NS	4.703	2.334	NS	5.611	2.784	NS	4.979	2.471	*	4.840	2.402	*	5.328	2.643	NS
CY	17.472	8.669	NS	15.600	7.740	NS	18.609	9.233	NS	16.514	8.194	NS	16.054	7.966	NS	17.670	8.767	NS

C-Cv.- Cultivar; Y-Year; CD- Critical Difference at 5% and 1%; S Ed- Standard Error of Deviation; DAP- Days After Planting; R- Replication (3); NS- Non Significant; **- Highly Significant ;*- Significant ignored. Rather they can be used as a good alternative source of food to alleviate hunger and malnutrition, which are currently big problems in developing countries such as India. We hope that this study will help propagate knowledge on the compositional varietal variation in elephant foot yam corms, their suitability for transformation into processed products like dried cubes, fried cubes and pickle, and their selection for further improvement. Furthemore, we hope this study willstimulate activity to promote the production and utilization of elephant foot yam as valuable components of a well balanced diet.

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