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Diversity in Morpho - Biometrical Characters, Nutritional Facts and Isozymes Activity of Indian Landraces of Upland Taro (*Colocasia esculenta* var. antiquorum L. Scott)

Surajit Mitra* and J.Tarafdar*

ABSTRACT: *Upland taro (*Colocasia esculenta *var. antiquorum L. Scott) mainly serves as a vegetable in the tropical countries, but in the Pacific Islands, it is cultivated as a staple food. It is gaining popularity as a starchy vegetable in areas where traditional vegetables become scarce during monsoon months. Being rich source of starch like other members of edible aroids, taro cormels finds its use in baby foods and diet of people allergic to cereals. Although, a large number of indigenous germplasms of upland taro are grown in India, information in detail on all aspects of the morphological, biometrical, nutritional and isozymes profile of the crops is very meager. Therefore, the present study was undertaken to identify the potential types of upland taro, which are gaining importance as a non conventional starchy vegetable in West Bengal and some parts of eastern India. Eighty two diverse landraces of taro were evaluated in randomized block design with three replications at the Horticultural Research Station, Bidhan Chandra Krishi Viswavidyalaya, Mondouri, Nadia, West Bengal, India under All India Coordinated Research Project on Tuber Crops during 2011 and 2012. The germplasms of upland taro showed marked variation in morphological characters, yields, its attributes, nutritional facts like dry matter, starch, total sugar, protein, vitamin C and anti-nutritional factors like calcium oxalate content. Electrophoretic analysis of isozymes of taro germplasms showed marked variation in band pattern of isoforms in healthy and* Phytophthora *infected plants showing a few additional bands of peroxidase (PO) in field resistant germplasms, lacking of that isoforms in susceptible germplasms and absence of both the common and additional bands in the highly susceptible germplasms to* Phytophthora *blight. Among eighty two germplasms of Indian taro, thireen germplasms namely BCC-1, BCC-2, BCC-8, BCC-9, BCC-10, BCC-11, BCC-16, BCC-17, BCC-21, BCC-32, BCC-36, BCC-42 and BCC-48 performed better in West Bengal and were considered as the most promising germplasms having higher yield, low disease incidence and better nutritional quality with slight or no acridity.*

INTRODUCTION

Taro (*Colocasia esculenta* var. antiquorum (L.) Schott) belonging to the family Araceae serves as a vegetable in the Tropical countries whereas, in the Pacific Islands, it is cultivated as a staple food. About 60% of the world production of taro is grown in Africa and most of the remaining 40% in Asia and Pacific. Upland taro has a small or medium sized corm and large number of edible cormels which makes a significant contribution both as root and vegetable in the diet of people. Taro is considered as an average source of major components of the diet viz., energy, proteins, minerals and vitamins. Further more, taro is a rich source of starch which finds its use in baby foods and diet of people allergic to cereals. There is considerable variability of chemical composition among the cultivars due to environmental and genotypic differences. Being an important vegetable of West Bengal, taro deserves greater attention for its nutritional quality and availability at the lean periods when there are not much vegetables to go in the market.

The *Phytophthora* leaf blight is the most important disease of taro caused by *Phytophthora colocasiae*, which causes a substantial loss of the tuber production. The different cultivars show differential reaction to the *Phytophthora* leaf blight under field conditions as well as under artificial inoculation by the pathogen. The peroxidases have a role in disease response to inactivate the pathogen by oxidizing the phenolics compound (Sharma *et al.*, 1990).

* All India Coordinated Research Project on Tuber Crops, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani-741235, Nadia, West Bengal, India (*E-mail: drsurajitmitra@yahoo.co.in*)

However, information in detail on all aspects of morphological, biometrical and nutritional status and isozymes profile of these crops are very meager. Furthermore, not much recognized national varieties of taro have so far been developed in India.

In view of all these observations, the present study was undertaken to evaluate the germplasms of taro collected from different districts of West Bengal and North Eastern States of India with a view to identify the potential types having higher productivity and better nutritional quality and no or little acridity.

MATERIALS AND METHODS

Eighty two diverse landraces of taro collected from different districts of West Bengal and North Eastern States of India were grown in the Horticultural Research Station, Bidhan Chandra Krishi Viswavidyalaya, Mondouri, Nadia, West Bengal, India during 2011 and 2012 in Randomized Block Design with three replications. Uniform standard cultural practices were followed for the experiment. The morphological characters like growth habit, length and girth of the main sucker (cm), length / breadth ratio of leaf lamina, leaf orientation, leaf colour, leaf margin colour, leaf arrangement, petiole junction colour, petiole colour and vein colour of each replication consisting of five plants were recorded during the grand growth period of the crop at 200-220 days after planting following the descriptor employed by International Board of Plant Genetic Resources. Yield and yield attributing characters like weight of individual cormel(g), length and girth of cormel (cm), number and weight of cormels (g) per plant were also recorded among the genotypes.

For estimating the dry matter content, 100 gm of cormels from each replicated cultivars were sliced and kept in oven at 70ºC for 24 hrs and dried samples were weighed periodically till they attained constant weight.. Total sugar (%), starch (%) and vitamin C (mg/100g) content of the stolons were measured following the standard protocols (Sadasivam and Manickam, 1952). The protein content of the stolons was determined by Lowry (1951) method. The acridity of the stolons in the form of calcium oxalate (mg/100g) was determined following the standard procedure. All the data were statistically analyzed.

For estimating the peroxidase (PO) and polyphenol oxidase (PPO) of the infected and healthy plants, enzyme extraction was carried out by taking 500 mg leaves both from the infected and healthy plants was crushed with extraction buffer (0.1 M Tris-HCL pH 7.4) pre-chilled pestle mortars. The homogenates were centrifuged at 13,000 rpm and clear supernatant was collected. The proteins content of collected supernatants were determined by Lowry (1951) method. The gel electrophoresis was performed using vertical slab gels followed by the method Laemmli (1970). On completion of electrophoresis the gels were incubated with staining solution in dark at room temperature for localization of PO isozyme bands in the loaded samples from disease and healthy plants of each cultivar. The enzyme activities of PO and PPO were also determined from all the test samples. PO activity was assayed using O-dianisidine as hydrogen donor and H_2O_2 as electron acceptor. The rate of information of yellow orange colored dianiside dehydrogenation was ensured spectrophotometrically at 430 nm. The enzyme activity of PPO was assured as the rate increases in absorbance calorimetrically at 410 with the oxidation of catechol as the substrate.

RESULTS AND DISCUSSION

The germplasms of taro showed marked variation in morphological characters (Table 1), cormel yield, its attributes (Table 2) and nutritional parameters (Table 3). Length of main sucker varied from 57.16-87.27 cm. The basal girth of the plants also differed among the germplasms ranging from 9.17-17.43 cm. Number of side suckers / plant varied from 2.14-4.69, number of petioles / clump varied from 5.62-16.78, length of petiole varied from 44.25-76.11 cm, length of leaf lamina varied from 24.34-39.41 cm, breadth of leaf lamina varied from16.17-28.57 cm and length/breadth ratio of leaf lamina varied from 1.11-1.59. Marked variations in cormel yield and its attributing characters were observed among the germplasms of upland taro. The cormel yield varied from 9.12-17.59 t/ha. Average length and girth of cormel varied from 3.12-6.89 cm and 5.42-11.21 cm respectively. Besides the length and girth of cormel, average weight of individual cormel and number of cormels per plant also varied among the germplasms (Table-2). Higher cormel production was associated with higher length, girth, weight of individual cormel and number of cormel per plant.

The germplasms of taro showed marked variation in morphological characters, cormel yield (9.6-17.4 t/ha), its attributes like individual cormel weight (13.3-29.1 g), cormel weight /plant (231.6-343.2 g), number of cormel /plant (8-17), and nutritional parameters like dry matter (22.77-25.46%), starch (13.71-18.36 %), total sugar (0.38-0.84%), protein (0.83-1.39) and vitamin C (3.12-5.69 mg/100 g) content of the cormels.

Table 1
Diversity in morphological characters of different taro germplasms

Character	*Mean*	*Range*
Length of main sucker(cm)	71.24	57.16-87.27
Girth of main sucker (cm)	13.19	9.17-17.43
No. of side suckers / Plant	2.78	2.14-4.69
No of petioles / Clump	8.51	5.62-16.78
Length of petiole (cm)	61.25	44.25-76.11
Length of leaf lamina (cm)	31.22	24.34-39.41
Breadth of leaf lamina (cm)	21.45	16.17-28.57
Length/ Breadth ratio of leaf lamina	1.23	1.11-1.59

Table 2
Diversity in yield and its attributing characters of different taro germplasms

Character	*Mean*	*Range*
No of cormels / Plan	13.27	9.36-23.12
Corm weight(g)	87.36	78.58-109.41
Weight of cormels / Plant (g)	280.63	140.81-409.46
Corm / Cormel ratio	0.27	0.21-0.38
Average weight of cormel (g)	23.17	15.64-27.32
Average length of cormel (cm)	4.22	3.12-6.89
Average girth of cormel (cm)	7.58	5.42-11.21
Cormel yield (t/ ha)	12.47	9.12-17.59

Table 3
Diversity in Nutritional facts of upland taro

Parameter	*Mean*	*Range*
Moisture (%)	76.62	74.54-77.23
Dry matter (%)	23.38	22.77-25.46
Starch (%)	16.21	13.71-18.36
Total Sugar (%)	0.57	0.38-0.84
Protein (%)	1.16	0.83-1.39
Vitamin C (mg/100g)	3.54	3.12-5.69

Among eighty two landraces of Indian taro, thirteen accessions namely BCC-1, BCC-2, BCC-8, BCC-9, BCC-10, BCC-11, BCC-16, BCC-17, BCC-21, BCC-32, BCC-36, BCC-42 and BCC-48 performed better in West Bengal, and were considered as the most promising genotypes having higher yield, low disease incidence and better nutritional quality with slight or no acridity.

Dwivadi and Sen (1998) also observed the significant variation in plant growth characters among different taro collections.

A great variation in yield and its attributing characters was also obtained by Tarafdar *et al*. (2004). Dry matter content of cormels among the genotypes of taro was found to vary from 22.77-25.46% with an average value of 23.38%. Starch content varied from 13.71-18.36% and variation recorded in protein content was 0.83-1.39%. Total sugar and vitamin C content were also found to vary among eighty two genotypes of taro studied recording 0.38-0.84% and 3.12-5.69% respectively. Variation in bio-chemical constituents was also recorded by Mitra *et.al.* (2007).

The results of field screening of nine cultivars of *Colocasia* against *Phytophthora* blight vary significantly among the cultivars. The disease incidence ranged from 14.3-78.5% and 17.8 – 88.6% respectively in the year 2011 and 2012. In both the year lowest and highest disease incidence was observed to the cultivar BCC-1(14.3 and 17.8%) and Telia (78.5 and 88.6%) respectively. The other cultivars like BCC-10, 24, 21, 25 showed moderate incidence of blight disease. In the compiled zymogram of peroxidase (PO), maximum eight isozyme bands (Rm 0.12- 0.88) were observed. The susceptible genotype Telia showed four bands (Rm 0.12, 0.53, 0.81 and 0.88). Four additional bands were observed to the genotypes BCC-16, Bcc-32 and BCC-21. From the comparison of isozyme profile (Fig. 1) of the genotypes of taro, it is suggested that the appearance of new PO isozyme bands in some genotypes may be involved in the manifestation of resistance against this fungus. PO activity increased in the resistant genotypes. Increase in PO activity in the resistant genotypes was also observed by Mitra *et.al.* (2007). Very high activity of PO was recorded in BCC-1 (4.02g /leaf tissue/ min.), followed by BCC-2, BCC-21, BCC-32 ranging from 3.89 to 1.95g/leaf tissue/ min.). The activity of poly phenol oxidase (PPO) was higher to the susceptible genotype Telia. The genotype BCC-1 showed highest activity of PO but lowest in PPO activity. In the study on the PO isoforms and activity of the enzyme, the PO has the positive role in response to infection. The results suggested that PO may oxidize phenolics and such oxidation prodicts may inhibit *Phytophtora colocasiae*. The additional bands in isozyme profile of PO in the resistant genotypes could have major role on suppressing the pathogen growth which are lacking to genotype Telia and also BCC-15. Vidyasekaran (1997) reviewed that PO and PPO activity would be more in the plants infection by pathogen and has great role in inhibition on the pathogenesis. Vidyasekaran (2000) reported that phenolics may not accumulate to fungi toxic levels but pathogens may produce toxins that suppress the host poly phenol oxidases.

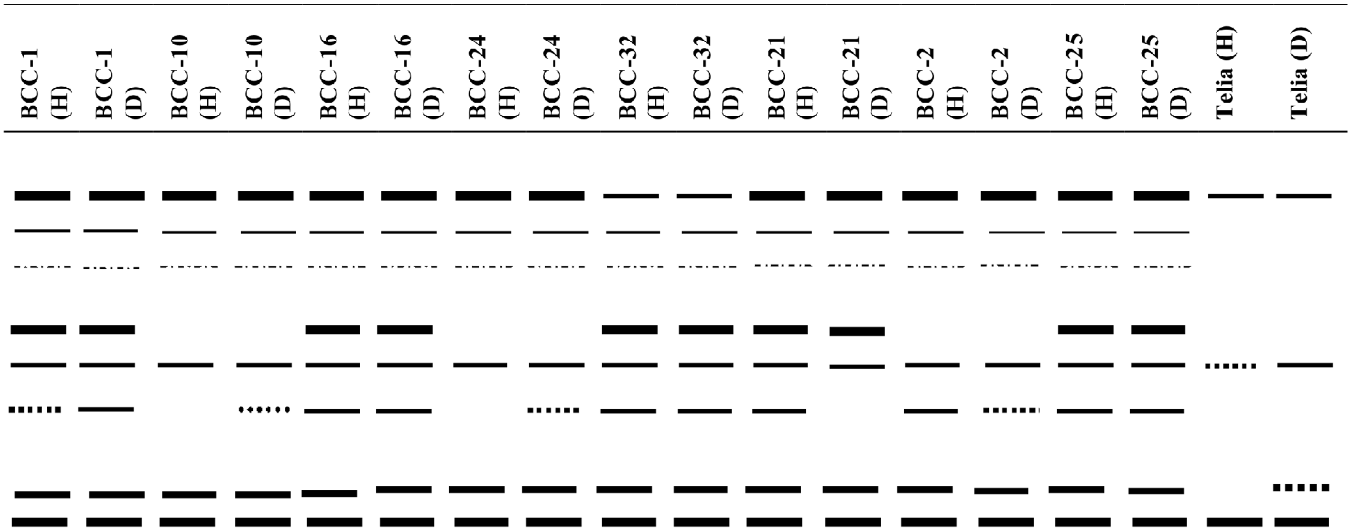

Figure 1: Compiled zymogram of the peroxodase (PO) isoenzyme profile in the healthy and infected plants of taro cultivars (H-Healthy, D-Disease)

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