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Morphological characterization of Taro [*Colocasia esculenta* (L.) Schott] germplasm

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Abstract
Taro (*Colocasia esculenta* (L) Schott.) is one of the major tuber crops which have great potential in terms of food and nutritional value. In the present study, 18 accessions of taro were evaluated at Research cum Instruction Farm, S. G. College of Agriculture and Research Station, IGKV, Jagdalpur (C.G.) during *kharif* 2020 in Randomized block design with three replications. Data were analyzed for 11 quantitative and 17 qualitative characters. A highly significant difference was observed for all characters except no. of stolen and no. of suckers. Undulated leaf blade margin observed in all germplasm and leaf blade colour variegation is absent. Variations were observed in the vegetative and yield components. This study provides details about morphological characters of taro and their use as food, region and season of cultivation. The genetic differences among the genotypes are potentially relevant to breeding programmes in that the variability created through hybridization of the contrasting forms could be exploited.

Keywords: Taro, *Colocasia esculenta*, Research cum Instruction Farm

Introduction
Taro [*Colocasia esculenta* (L.) Schott] belonging to the monocotyledonous family Araceae whose members are known as aroids (Van Wyk, 2005) [14] and it is the fourth most consumed tuber crop in the world (Revill *et al*., 2005) [12]. It is most extensively cultivated in Southeast Asia by several common names like Arbi, Arvi and Eddoe. The most commonly reported chromosome numbers are: diploids 2n = 28 and triploids 3n = 42 (Kuruvilla and Singh, 1981) [6]. There are eight recognized variants within *Colocasia esculenta*, of which two are commonly cultivated i) *Colocasia esculenta* (L.) Schott var. *esculenta* which possesses a large cylindrical central corm and only few cormels; agronomically it is referred to as the dasheen type of taro and (ii) *Colocasia esculenta* (L.) Schott var. *antiquorum* which has a small globular central corm with several relatively large cormels arising from the corm; agronomically this variety is referred to as the eddoe type of taro. Colocasia species is an ancient crop used all over the world; Africa, Asia, the West Indies, and South America. It is grown throughout the humid tropics. In India, it is commercially cultivated in West Bengal, Orissa, Chhattisgarh, Bihar, Aasam, Maharastra and Uttar Pradesh. *Colocasia esculenta* (L) Schott of the family Araceae is an herbaceous perennial plant. The crop is cultivated as annuals. The green leaves of the plant are large in size and are described as 'Elephant ear'. Plant can reach up to 1-2 m height during growth period.

The main edible parts of the crop are the starchy, tuberous roots; however, the leaves of the plant are also used as a leafy vegetable. The leaves of *C. esculenta* have been reported to be rich in nutrients including minerals and vitamins. The corm of taro is an excellent source of carbohydrate and its digestibility is estimated to be 98% (Deo *et al*., 2009) [3]. Due to its ease of assimilation, it is suitable for persons with digestive problems. The leaves of taro have higher levels of protein, potassium, calcium, phosphorous, iron, vitamin A, thiamine, niacin, riboflavin and dietary fibre (Xu *et al*., 2001; Yared, 2007) [15, 16].

Germplasm is the basic raw material for any crop improvement programme. Conservation and use of genetic resources have a great significance. The precise evaluation of genetic stock and dissemination of findings is an important for their utilization in breeding programme. The knowledge of variability of *Colocasia esculenta* is limited. Morphological study on genotypes of taro becomes a necessity because morphological characters are the strongest tools used in taxonomic classification of plants, and this makes its application very crucial (Ezeabara *et al.*, 2015) [4]. Germplasm characterization and evolutionary process in viable populations are important links between the conservation and utilization of plant genetic resources (Mandal *et al*., 2013) [9]. Therefore, the objective of this study was to characterized taro evaluating 18 entries for 28 descriptors which included morphological and corm growth habit.

Material & methods

The experimental material of present study comprised of a set of 18 germplasm of taro including two local check varieties and seven entries obtain from CTCRI and remaining collected from different places of Chhattisgarh. The germplasm lines/genotypes were evaluated in a Randomized Block Design with three replications at Research cum Instruction Farm, S. G. College of Agriculture and Research Station, IGKV, Jagdalpur (C.G.) during *kharif* 2020. The experimental site was located at an altitude of 552 m above the mean sea-level, with the geographical location of 19°085'N latitude, 82°018'E longitude with an annual rainfall range of 1200-1400 mm. The recommended spacing (60 cm x 45 cm), plot size (3 m X 2 m) and package of practices were adapted uniformly to all the genotypes. Necessary prophylactic plant protection measures were carried out to safeguard the entire germplasm from pests and diseases.

Genotypes were characterized for 17 qualitative characters *viz*., predominant position (shape) of leaf lamina surface, leaf blade margin, leaf blade colour, leaf blade colour variegation, leaf blade margin colour, petiole junction pattern, petiole junction colour, leaf main vein colour, vein pattern, petiole colour, Petiole basal-ring colour, Cross-section of lower part of petiole, flower formation, shape of corm, shape of cormels, corm flesh colour of central part, corm skin surface, according taro descriptors developed by IPGRI, 1999 [5]. The data on 11 quantitative characters *viz*., plant height (cm.), no. of cormels, no of suckers, corm weight (g), cormel weight (g), corm length (cm.), corm diameter (cm.), cormel length (cm), cormel diameter (cm), yield per plant (g) and yield per hectare (tonne) were recorded on five competitive and randomly selected plants in each replication for all the characters. Data were analyzed following Panse and Sukhatme (1985) [10].

Results and discussion

The Eighteen taro cultivars under the study showed high levels of significant variability for plant growth habit. The genotypes significantly differed for all characters under this study. In the present investigation, out of 18 genotypes, 44.44% had showed horizontal; position of leaf lamina and erect-apex down position also had 44.44% followed by 16.67% of genotypes had cup shaped leaf lamina surface. The variations in different growth habit of taro was also reported by Boampang *et al*. (2018) [2].

The Leaf blade margin, entire and undulate characterization is found in colocasia. According to leaf blade margin, all genotypes had undulated leaf blade margin. In leaf blade colour, yellow green, green and dark green colour found in taro. Most of genotypes had purple leaf blade (44.44%) followed by yellow green leaf blade (38.89%), green colour (11.11%), while only one genotype recorded for dark green leaf blade colour (5.56%). Out of 18 genotypes, 8 genotypes were observed purple followed by 7 genotypes showed yellow or yellow green, 2 genotypes were green and 1 genotype was dark green respectively. Leaf blade colour variegation in taro is a very distinct character. Out of 18 genotypes, variegation is found to be absent. The Leaf blade margin colour was observed to variable and 72.22% (13 genotypes) found purple colour followed by yellow colour 16.66% (3 genotypes) and green colour 11.11% (2 genotypes).

The Petiole junction pattern was observed to variable and medium pattern petiole junction found 55.55% (10 genotypes) of genotype, followed by 38.88% (7 genotypes) in small pattern and 5.55% (1 genotype) in large pattern. The Petiole junction colour was observed to variable and purple colour found 55.55%, followed by green 27.77% and yellow 16.66%. Out of 18 genotypes, 10 genotypes were observed purple followed by 5 genotypes are green and 3 genotypes are yellow respectively. The leaf main vein colour, whitish, yellow, orange, green, pink, red, brownish and purple colour characterization is found in taro. Out of 18 genotypes, in all genotype green leaf vein colour is found. The leaf vein pattern, V, I and Y pattern is characterized. Out of 18 genotypes, all genotypes showed Y pattern leaf vein. The Petiole colour was observed to variable and purple and light green colour found 44.44%, followed by yellow and green colour 5.55 %. Out of 18 genotypes, 8-8 genotypes were observed purple and light green colour followed by 1-1 genotypes yellow and green colour respectively. The Petiole basal-ring colour was observed to variable and Green (yellow green) found to be 55.55% (10 genotypes) of genotype, followed by 44.44% (8 genotypes) in purple.

Cross-section of lower part of petiole was observed to variable and open cross-section found to be 88.89% (16 genotypes), followed by 11.11% (2 genotypes) in closed cross-section. Flower formation is rare in colocasia and mostly depends upon season of cultivation. Flower formation found to be absent in 12 genotypes (66.67 %) and present in 6 genotypes (33.33%).

Corm shape was observed to variable and round corm shape recorded 55.56% (12 genotypes) of total genotype, followed by cylindrical shape 27.70% (5 genotypes) and 16.66% conical shape (3 genotypes). Corm flesh colour of central part was observed to variable and white corm flesh colour found in 50% (9 genotypes) of genotype, followed by cream colour 44.44% (8 genotypes) and 5.55% showed (1genotypes) light purple flesh colour. Corm skin surface was observed to variable and fibrous corm skin surface recorded in 61.11% (11 genotypes) of genotype, followed by smooth surface 38.88% (7 genotypes). Shape of cormel was observed to variable and conical cormels shape observed in 44.44% (8 genotypes) of genotype, followed by 27.78% (5 genotypes) in elliptical, 16.67% (3 genotypes) in elongated and 11.11% (2 genotypes) in elongated and curved.

All 11 quantitative characters embracing plant growth and corm characters varied significantly among the 18 germplasm (Table 2). The genotypes were dwarf to tall (30.33 cm to 112.33 cm plant height). No. of cormels ranges from few to many (4 to 16.33), it is most important character which contributes for plant yield. No. of suckers varied from 2.66 to 9.33. Corm weight varied from 35.300 g to 254 g in germplasm with average corm weight 144.66 g while, cormel weight per plant ranges between 72.5 g to 680 g with average cormel weight of 376.25 g per plant. These two characters are directly contributes for yield. Corm length varied from 3.3 cm to 11.6 cm with an average corm length of 7.45 cm while, corm diameter ranges between 2.85 cm to 8 cm with an average corm diameter of 5.42 cm. Cormel length varied from 2.2 cm to 10.93 cm with an average cormel length of 6.56 cm while, corm diameter ranges between 1.4 cm to 3.9 cm with an average corm diameter of 2.65 cm. Yield is very complex character and governs by many factors. In a set of 18 germplasm yield per plant ranges between 147.33 g to 1066.33 g with an average of 606.83 g. Yield per hectare varied from 5.18 tonne to 39.49 tonne with an average yield of 22.34 tonne per hectare depending upon genotypes. These results are in line with the experiments performed by Sitompul and Guritno (1995) [13], Angami *et al.,* (2015) [1], Pratiwi *et al.,* (2014) [11] and Luwe *et al.,* (2017) [8].

Table 1: Morphological descriptors, descriptor scales and distribution of colocasia/taro germplasm

S. No.	The trait/descriptor	Class or scale of descriptor	Distribution by classes of descriptor
1.	Predominant position (shape) of leaf lamina surface	1= Drooping	
		2= Horizontal	8 (44.44%)
		3= Cup-shaped	3 (16.67%)
		4= Erect - apex up	
		5= Erect - apex down	8 (44.44%)
2.	Leaf blade margin	1= Entire	
		2= Undulate	18 (100%)
3.	Leaf blade colour	1= Whitish	
		2= Yellow or yellow green	7 (38.89%)
		3= Green	2 (11.11%)
		4= Dark green	1 (5.56%)
		5= Pink	
		6= Red	
		7= Purple	8 (44.44%)
		8= Blackish (violet-blue)	
4.	Leaf blade colour variegation	0= Absent	18 (100%)
		1= Present	
5.	Leaf blade margin colour	1= Whitish	
		2= Yellow	3 (16.67%)
		3= Orange	
		4= Green	2 (11.11%)
		5= Pink	
		6= Red	
		7= Purple	13 (72.22%)
6.	Petiole junction pattern	0= Absent	
		1= Small	7 (38.89%)
		2= Medium	10 (55.56%)
		3= Large	1 (5.56%)
7.	Petiole junction colour	0= Absent	
		1= Yellow	3 (16.67 %)
		2= Green	5 (27.78%)
		3= Red	
		4= Purple	10 (55.56%)
8.	Leaf main vein colour	1= Whitish	
		2= Yellow	
		3= Orange	
		4= Green	18 (100%)
		5= Pink	
		6= Red	
		7= Brownish	
		8= Purple	
9.	Vein pattern (Shape of pigmentation on veins on leaf lower surface)	1= V pattern (in a ‘V’ space)	
		2= I pattern (in an ‘I’ shape)	
		3= Y pattern (in a ‘Y’ shape)	18 (100%)
		4= Y pattern and extending to secondary vein	
10.	Petiole colour	1= Whitish	
		2= Yellow	1 (5.56%)
		3= Orange	
		4= Light green	8 (44.44%)
		5= Green	1 (5.56%)
		6= Red	
		7= Brown	
		8= Purple	8 (44.44%)
11.	Petiole basal-ring colour	1= White	
		2= Green (yellow green)	10 (55.56%)
		3= Pink	
		4= Red	
		5= Purple	8 (44.44%)
12.	Cross-section of lower part of petiole	1= Open	16 (88.89%)
		2= Closed	2 (11.11%)
13.	Flower formation	0= Absent	12 (66.67%)
		1= Rarely flowering (less than 10% of plants flowering)	6 (33.33%)
		2= Flowering (more than 10%1 of plants flowering)	

14.	Corm shape	1= Conical	3 (16.67%)
		2= Round	10 (55.56%)
		3= Cylindrical	5 (27.78%)
		4= Elliptical	
		5= Dumb-bell	
		6= Elongated	
		7= Flat and multifaced	
		8= Clustered	
		9= Hammer-shaped (not illustrated)	
15.	Corm flesh colour of central part	1= White	9 (50.00 %)
		2 = Yellow	
		3= Cream	8 (44.44 %)
		4 = Pink	
		5 = Red	
		6 = Red Purple	
		7 = Light Purple	1 (5.56%)
16.	Corm skin surface	1= Smooth	7 (38.89%)
		2= Fibrous	11 (61.11%)
		3= Scales present	
		4= Fibrous and scales present (not illustrated)	
17.	Shape of cormels	1= Conical	8 (44.44%)
		2= Round	
		3= Cylindrical	
		4= Elliptical	5 (27.78%)
		5= Elongated	3 (16.67%)
		6= Elongated and curved	2 (11.11%)

Table 2: Quantitative characteristics of 18 germplasm of colocasia/taro

Characters	Range		Mean (X)	SEd	CD (@5%)	CV %
	Minimum	Maximum				
1.Plant height (cm)	30.33	112.33	71.33	3.83	7.78	9.60
2.No. of cormels	4.00	16.33	10.16	1.76	3.57	23.86
3.No. of sukers	2.66	9.33	5.99	0.83	1.68	21.45
4.Corm weight/ plant (g)	35.33	254.00	144.67	19.22	39.06	20.26
5.Cormels weight/ plant (g)	72.50	680.00	376.25	30.28	61.54	13.78
6.Corm length (cm)	3.30	11.60	7.45	0.52	1.06	11.31
7.Corm diameter (cm)	2.85	8.00	5.42	0.65	1.33	17.54
8.Cormels length (cm)	2.20	10.93	6.56	0.77	1.56	15.83
9.Cormels diameter (cm)	1.40	3.90	2.65	0.30	0.61	14.52
10.Yield/ plant (g)	147.33	1066.33	606.83	40.55	82.4	11.56
11. Yield/ hac. (tonne)	5.18	39.49	22.33	1.50	3.05	12.89

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