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Morphological variation of *Colocasia esculenta* var. *esculenta* (L.) Schott. (Poidnal kachu) germplasms in Bangladesh

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ABSTRACT

Poidnal kachu upland taro substantially grown in Bangladesh and used as food, medicine, fodder and ornamental. This study, poidnal kachu collection, morphological characterization and genetic variation were undertaken. According to descriptors for taro (IPGRI), with some modifications, 13 morphological components were characterized to find the nature and extent of variability in the germplasms of poidnal kachu (upland taro). A significant differences and wide range of variation was recorded for most of the characters indicate the existence of variability among the germplasms. Maximum yield was achieved from CE-22, whereas minimum was from CE-20. Genetic advance of all characters was above 20% except leaf number and leaf breadth. Genotypic coefficients of variation values were lower or very close to than that of phenotypic coefficients of variation, indicating less influence on the environment in the expression of these characters and potentiality of selection. Effective breeding program depends upon the variation present in the gene pool for the yield enhancing traits. Selection is effective when magnitude of variability in the breeding population is enough. The outcome of study may be helpful in selecting yield contributing traits and enhancing the rhizome yield of taro.

Key words: Taro, tan colour, fodder crop, germplasm, coefficient of variation.

INTRODUCTION

Poidnal kachu, natively known as Banshkachu, Chinn kachu, Garo kachu in Bangladesh, Gaderi in India. Eddoe/Dasheen (*Colocasia esculenta* L.) in English. This species is native to tropical Asia and South West Pacific as well as Pakistan to Bangladesh and China, Philippines and Sri Lanka and well distributed throughout the tropical and subtropical countries of the world like Malaysia, Australia, America, Thailand and Vietnam (Hooker, 5). It is thought to be native to Bangladesh, probably India or Malaysia (Onwuem,11). It has elongated large central corm and several smaller elongated cormel (4-6) attached more compactly with central corm. Poidnal kachu belongs to the family Araceae and is cultivated mainly in developing countries using low input production systems and no serious disease, insects or pests. It is a herbaceous perennial plant and harvested after 8 to 9 months of growth. There are two types of varieties have been found so far. One has heart-shaped green leaves together with light brown long petioles (0.8-1.2 m) another one has deep green leaves but petioles tan in colour. The variation of leaf shape was found such as heart shaped and peltate in poidnal kachu. Leaves and petioles do not always have the same colour. Leaves colour also varied dark green and dark purple under lower side in poidnal kachu, fibrous roots, cylindrical central corm which surrounded by more than four secondary corms. The plant is used for various purposes such as fodder crop, medicine and ornamental plant worldwide. Poidnal kachu is an underutilized upland taro that can be commercially cultivated in rain-fed high land with heavy humus soil or organic fertilizers and plays an important role as summer vegetable in the lean period when other vegetables are scarce in the market (Khatemenla *et al*., 7). Tubers (central corm and secondary corm) are used as vegetables having potentials to contribute in reducing malnutrition.

The edible corm is rich in carbohydrates, calcium, iron, potassium, phosphorus, manganese zinc and vitamins such as vitamin A, vitamin C, Vitamin B, riboflavin, thiamin, niacin and dietary fiber. Its starch digestibility has been estimated to be 98.8%. However, it is suitable for persons who have digestive problem, useful to people allergic to cereals and children who are sensitive to milk. The corm also contains large amounts of vitamin B-complex than whole milk and higher in protein rather than Tannia/ *Xanthosoma* sp. (Arifur, 2; Lee, 8). Taro can grow well in saline soil due to its tolerance to salinity (Onwueme *et al*., 11). In Bangladesh, this crop plant mainly concentrated in Tilla areas of Madhupur of Tangail, Fulbaria, Muktagasa and Haluaghat of Mymensingh, Bhawal of Gazipur districts and also Sylhet hilly areas, Chittagong and Chittagong Hill Tracts due to the requirement of high land and can be grown as inter crop with pineapple in hilly areas

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(Rahim *et al*., 13). The total rainfall is 2362 mm (app) if not irrigation applicable. It cannot tolerate waterlogging. Sandy loam and loose around 15-20 cm soil with good drainage system is best for cultivation. Cutting of cormel and apical portion of corm with 2 or more eyes are used as seed. According to Rahim *et al*. (13) best time for cultivation on February to April and harvested during September to October in Bangladesh. It is palatable, good in taste, no acridity and can be eaten without boiled. Annual yield is 25-35 t ha^{-1} in Bangladesh. Poidnal kachu can be played an agricultural diversified crop to address food security and poverty alleviation of rural peoples (Akwee *et al*., 1). Lack of suitable varieties and standard production techniques, farmers grow this crop according to their own methodology. Therefore, the main goal of this research was to find out desirable poidnal kachu varieties and standard production technology. Hence, the collected germplasms could be utilized for further breeding programs or research studies aimed at varietal improvement.

Evaluation of genetic diversity is important to know the source of gene for a particular trait within the available germplasms (Tomooka, 17). Selection of germplasms of any crop production system and characterization of existing genetic variability is pre-requisite for any breeding program (Rafiqul, 14). For effective selection process, information on nature and magnitude of variation within the population, association of yield contributing characters and extent of environmental influence on the expression of these characters are necessary. Genetic diversity has limitations when assessed based on external phenotypic characters, because most of the external characters are greatly modified or influenced by environmental factors (Rafiqul, 14). Corm yield is a quantitative characteristic influenced by several yield contributing characters. Therefore, this research aimed to evaluate genetic attributes for corm yield and its contributing parameters to established effective selection criteria for higher corm production through the study of genetic variability, characterization and evaluation of collected germplasms, determining their genetic variability by exploiting morphological characteristics.

MATERIALS AND METHODS

The collected germplasms were planted at the Fruit Tree Improvement Project (FTIP), Germplasm Center, Department of Horticulture, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh. Five germplasms of *Colocasia esculenta* var. *esculenta* (L.) were collected from different areas such as CE-20 (Poidnal- green)/ Bansh/ Garo from Gazipur, CE-21 (Poidnal- black) from Gazipur, CE-22 (Poidnal-black) from Madhupur, CE-23 (Poidnal- black) from Tangail, CE-24 (Poidnal- green) from Tangail district of Bangladesh. The experiment was carried out according to Randomized Complete Block Design (RCBD) with three replications. For plantation, in case of Poidnal or Garo kachu which produces elongated corms, the apical portions of the corm and cormels measuring about 6cm in length were used. The experimental field was characterized by sandy loam texture and medium high land belonging to the Old Brahmaputra alluvium. The pH value of the soil was ranging from 6.5 to 6.7. The size of s unit plot was 3.0 m to 4.0 m with a spacing of 60 cm × 60 cm. The agronomical cultivation practices were done properly whatever needed. Harvesting was done when all the plants attained full maturity and leaves become pale yellow in colour.

Five hills were selected at random from each unit plot for collection of data on different morphological parameters. All data were recorded according to the IPGRI (6) descriptors for taro with some modifications. Statistical analysis was done for analyzing to find out the statistical significance of the experimental results based on the data collected from different components. The data were analyzed by Statistix-10 program and means were calculated by Latin Square Design (LSD) test at a 5% level of significance for interpretation of the results.

RESULTS AND DISCUSSION

Remarkable variation observed among the collected germplasms in different qualitative and quantitative characters. The qualitative characters such as leaf shape, leaf colour, petiole colour, corm and cormel shape, colour of corm flesh all were used to as morphological characteristics (Table 1). Colour of leaves varied from deep green to yellowish green depending on the germplasms (Table 2). CE-20 and CE-24 were yellowish green or light green but the petioles light brown in colour. Leaves of CE-21, CE-22, CE-23 were deep green and petioles deep brown or black in colour. Leaf shape was heart shaped all the germplasms. The corm and cormels shape were cylindrical or elongated. The corm was rather shorter than respective cormels. Each corm has more than four cormels. The colour of corm flesh was white in CE-20 and CE-24. While CE-21, CE-22, CE-23 had slightly off white colour.

The plant height was medium in CE-20 and CE-24, whereas rest of all tall. The lowest plant height (93.33 cm) was observed in CE-20 and highest was (124.33 cm) in CE-22 (Table 2). The longest petiole length was noticed at CE-22 (106.55 cm), whereas shorter (72.43 cm) in CE-20. Leaf number was maximum in CE-24 (3.27), while minimum in

Table 1. Morphological qualitative studies of germplasms of taro collected from different districts.

Germplasm number	Growing condition	Growth habit	Plant size	Petiole colour	Leaf colour	Leaf shape	Eating quality	Corm shape	Colour of corm flesh
CE-20	High land	Erect	Tall	Dark green	Light green	Heart shaped	Good	Cylindrical, Elongated	White, Soft
CE-21	High land	Erect	Tall	Dark purple with tent	Dark green	Heart shaped	Acceptable	Elongated	White
CE-22	High land	Erect	Tall	Dark purple with tent	Dark green	Heart shaped	Acceptable	Elongated	White
CE-23	High land	Erect	Tall	Dark purple with tent	Dark green	Heart shaped	Acceptable	Elongated	White
CE-24	High land	Erect	Tall	Dark green	Light green	Heart shaped	Good	Cylindrical, Elongated	White, Soft

Table 2. Morphological characteristics of five germplasms of taro.

Character	Plant height (cm)	Petiole length (cm)	Leaf number	Leaf length (cm)	Leaf breadth (cm)	Corm length (cm)	Corm breadth (cm)	Corm weight (g)	Cormel number	Cormel length (cm)	Cormel breadth (cm)	Cormel weight (g)	Yield per plant (g)
CE-20	93.33	72.43	3.07	30.67	29.67	15.52	10.83	390.00	2.40	8.93	6.97	128.50	518.50
CE-21	120.00	88.06	2.80	37.33	33.00	17.97	13.13	431.00	2.73	10.50	8.47	221.00	652.00
CE-22	124.33	106.55	3.20	39.67	37.00	23.17	15.89	648.00	3.53	13.15	10.20	329.67	977.67
CE-23	116.48	102.28	2.67	35.33	34.33	22.25	15.25	602.53	3.13	12.60	9.82	339.42	941.45
CE-24	100.70	78.22	3.27	32.76	30.98	16.37	11.73	407.73	2.53	9.72	7.60	137.77	545.50
$LSD_{(0.05)}$	5.89	2.42	0.19	1.53	1.67	1.05	1.34	10.86	0.40	0.63	0.82	8.22	12.98

CE-23 (2.67). CE-22 had the highest (39.67 cm) leaf length and lowest (30.67 cm) found in CE-20. The highest (39.67 cm) leaf length was observed in CE-22, followed by CE-21937.33) and lowest was from CE-20 (30.67). The leaf breadth was found maximum in CE-22 (37.00 cm), while minimum in CE-20 (29.67 cm). Corm length exerted highest in CE-22 (23.17 cm), whereas lowest was in CE-20 (15.52 cm). The highest corm breadth obtained in CE-22 (15.89 cm) and lowest was in CE-20 (10.83 cm). Corm weight was recorded maximum from CE-22 (648.00 g), while minimum was CE-20 (390.00 g). CE-22 scored highest number (3.53) of cormels and lowest was found in CE-20 (2.40). Cormel length (13.15 cm) was the longest recorded in CE-22, whereas smallest cormel length (8.93 cm) in CE-20. CE- 22 (10.20 cm) having the maximum breadth, while minimum (6.97 cm) in CE-20. The highest cormel weight was getting from CE-22 (339.42 g) and the lowest from CE-20 (128.50 g). The maximum yield per plant was obtained in CE-22 (977.67 g), minimum (518.50 g) in CE-20 (Table 1).

The research findings exhibited significant variation in all studied characters of the germplasms under investigation. The highest plant height (124.33 cm), petiole length (106.55 cm), leaf length (39.67 cm) was obtained from CE-22 (Fig. 1). The highest corm length was obtained from CE-22 (23.17 cm), corm breadth (15.89 cm), corm weight (648.00 g), cormels number (3.53), cormel length (13.15 cm), cormel breadth (10.20 cm) and the highest yield per plant was obtained from Ce-22, whereas CE-20 had the lowest yield for almost all the characteristics. This result proclaimed that high food reserves in large corms, which increased vegetative growth and plant development leading to produce higher number of cormels and higher total yield. The weight of corm, cormels and yield per plant had significant variance (Thakur *et al*., 16). Deshmukh *et al*. (3) reported that genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) values are greater than 20% considered as high, values less than 10% are low, values between 10% and 20% are considered medium.

The table 3 has shown maximum amount of genotypic and phenotypic coefficient of variation (GCV and PCV) of five germplasms of poidnal was recorded in cormel weight (43.63 and 43.72) and minimum was recorded in leaf number (8.07 and 9.58) and leaf breadth (8.38 and 9.30). GCV and

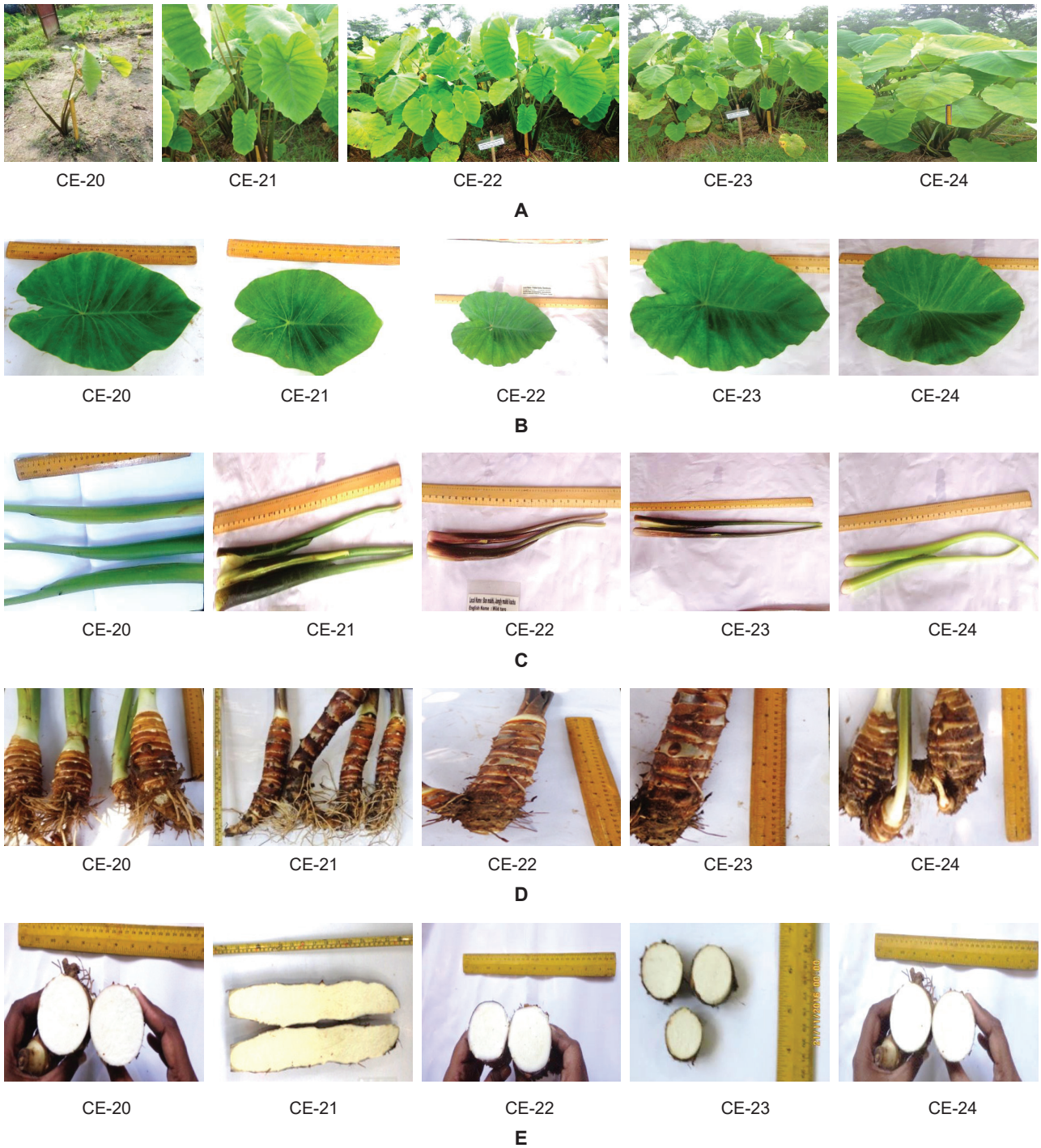

Fig. 1. Variation showing plant parts of taro (A = Whole plant, B = Leaf, C = Petiole, D = Corm, E = Flesh colour).

PCV of most of the characters were below 20% but above 10% except leaf number and leaf breadth. So, most of the characters GCV and PCV were medium in nature except corm weight, cormel weight and yield per plant are high in nature. GCV values were lower or very close than that of PCV, indicating that the environment had less influence in the expression of these characters. Hence, selection may be very effective for these characters. Similar research confined by Padmakshi *et al.* (10) and Mukherjee *et al*. (9) expressed that high GCV and PCV in *Colocasia* for number of cormels and weight of corms per plant.

Table 3. Estimates of genetic variability among thirteen characters of Poidnal germplasms.

Character	Plant height (cm)	Petiole length (cm)	Leaf number	Leaf length (cm)	Leaf breadth (cm)	Corm length (cm)	Corm breadth (cm)	Corm weight (g)	Cormel number	Cormel length (cm)	Cormel breadth (cm)	Cormel weight (g)	Yield per plant (g)
GV	151.20	217.46	0.06	12.26	7.65	11.78	4.39	14401.45	0.18	3.25	1.79	10182.67	47733.65
PV	173.16	221.17	0.08	13.75	9.41	12.47	5.52	14476.03	0.28	3.51	2.21	10225.39	47840.23
GCV	11.14	16.48	8.07	9.96	8.38	18.01	15.67	24.20	14.88	16.42	15.54	43.63	30.05
PCV	11.92	16.62	9.58	10.55	9.30	18.54	17.57	24.26	18.55	17.06	17.29	43.72	30.08
h2	87.32	98.32	70.97	89.21	81.37	94.45	79.47	99.48	64.39	92.71	80.80	99.58	99.78
GA	23.67	30.12	0.42	6.81	5.14	6.87	3.85	246.57	0.71	3.58	2.48	207.44	449.57
GA %	21.45	33.65	14.01	19.38	15.58	36.06	28.77	49.73	24.60	32.58	28.77	89.70	61.83

The highest heritability was observed in yield per plant (99.78) and the lowest in cormel number (64.39). High heritability was observed almost all the characters of five poidnal germplasms, which indicating that selection would be effective. According to Singh and Narayanan (15) the estimates of genetic advance help in understanding the type of gene action involved in the expression of various polygenic characters. High values of genetic advance are indicative of additive gene action whereas low values are indicative of non-additive gene action. The range for genetic coefficient of variation of five poidnal kachu was from 8.07 % for leaf number to 43.63% for cormel weight. Genetic advance as percentage of mean (GAM) of leaf number (14.01%) and leaf breadth (15.58%) are only lower than 20% which indicated that all studied characters genetic advance were very high in nature. Therefore, variability exists among the germplasms. High heritability estimates have been found to be useful in making selection of superior germplasms on the basis of phenotypic performance. High heritability associated with high genetic advance is the most effective condition for selection (Gandhi *et al*., 4 ; Panse, 12). The research finding of poidnal kachu confined a broad range of variability exists due to significant variation in all most all the germplasms. Similar observation was reported by Padmakshi *et al*. (10) in *Colocasia esculanta* var. *antiquorum*.

Poidnal kachu plays an important role as vegetable in the lean period of the Kharif season and meets the rural peoples demand in Bangladesh. The cultivation of poidnal kachu is increasing day by day. Based on the findings of the study by examining the morphological variation in the germplasms, the potential variant is CE-22. High heritability coupled with high genetic advance per mean (GAM) was noticed higher on almost all the yield contributing characters except leaf number (14.01%) and leaf breadth (15.58%) are lower than 20%, indicates that they can be exploited for varietal improvement and used as a genetic material for further breeding programs.

However, poidnal kachu production may contribute to food, nutrition security, income generating cash crop and poverty alleviation in Bangladesh. Hence, the selection of high yielding and good quality variety or germplasm will fulfill farmer's demand.

AUTHORS CONTRIBUTION

Writing - original draft, Formal analysis, Software, Data curation (SB); Investigation, Writing – review and editing, Supervision, Validation (MAR); Writing – review and editing (MHR); Formal analysis, Conceptualization, Investigation (MAZAM).

DECLARATION

The authors declares that they have no conflict of interest.

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