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Morphological Characterization of some *Colocasia* (*Colocasia esculenta* L. Schott) genotypes of North- East India

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ABSTRACT: A morphological study was conducted in Assam state in 2017-18 to compare fifteen varieties of Taro (*Colocasia esculenta* L. Schott). The aim of this study was to provide plant taxonomists with valuable information that could assist in distinguishing and defining these varieties. The results revealed that the petiole length was highest (103.40±68.40cm) in Moh-Khuti, whereas the least was in Ghoti-Kachu (56.80±32.60cm). The plant girth ranged from 17.48cm (Moh-Khuti) to 13.28cm (Red Garo), while the number of leaves ranged from (4.67) Bor-Kachu to AAU-Col-32 (2.93). This research highlights the distinctive and distinguishing morphological features that can aid in the identification and description of various varieties of *C. esculenta.* Furthermore, it offers supplementary data that could potentially contribute to resolving the existing taxonomic debate surrounding c*olocasia*. The outcomes of this study may ultimately facilitate the accurate delimitation of *C. esculenta.*

Keywords: *Colocasia*, Diagnostic characters, Morphological characters, Plant taxonomy.

INTRODUCTION

Taro (*Colocasia esculenta* (L) Schott. var. *antiquorum*) known as *eddoe* type *or Arvi* belongs to the monocotyledonous family Araceae, whose member is known as aroid (Van Wyk, 2005). 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). Taro is an important tuber crop and is grown mostly as subsistence crop throughout the tropics and sub-tropics. It is believed that the origin of domesticated taro is from 'wild type' *C. esculenta* var. *aquatilis*, which is from North East India or South East Asia (Matthews, 1991). Taroholds significant importance as staple food worldwide and is considered the fourteenth most consumed vegetable (Rao *et al.*, 2010). In India, it is cultivated extensively with major growing regions including Uttar Pradesh, Bihar, Punjab, West Bengal, Assam, Uttarakhand, Orissa, Andhra Pradesh and Tamil Nadu (Misra and Chowdhury 1997). Assam being part of the biodiversity-rich North East India, exhibits no variability in *colocasia* varieties presenting opportunities for selection and evaluation. Hence, this study aimed to assess fifteen Colocasia genotypes based on crucial morphological characters. *Colocasia* plants relies on the similarities and differences among them primarily based on the characters they possess. By providing additional morphological information, this study contributes to resolving the ongoing controversy in the taxonomy of c*olocasia*. Consequently, it could potentially facilitate the delimitation of *C. esculenta* (Ezeabara *et al.*, 2015). Additionally, taro is recognized for its medicinal properties offering benefits against tuberculosis, ulcers and fungal infections (Singh *et al.*, 2012).

MATERIALS AND METHODS

Site of genotypes collection. The materials for the present investigation comprised of 15 genotypes of *Colocasia esculenta* var. *stolonifera* collected from different parts of North eastern regions of the country. The list of the materials and the sources from where they were collected are given in Table 1.

Table 1: List of genotypes.

Sr. No.	Genotype name	Place of collection
1.	Red Garo	Tura
2.	Mohkhuti	Kokrajar
3.	Koni Kachu	Jorhat
4.	Naga -2	Mokokchung
5.	Kaka-Kachu	Jorhat
6.	Ghoti-Kachu	Jorhat
7.	Ahina	Jorhat
8.	Domor Dima	Dhupdhora
9.	Arunchal-7	Pasighat
10.	Bor-Kachu	Moran
11.	AAU-Col-46	Diphu
12.	AAU-Col-32	Diphu
13.	Garo	Tura
14.	Karbianglong	Diphu
15	Boga Ahina	Jorhat

Location. The experimental site was situated at an elevation of 86.8 meters above mean sea level, positioned geographically at latitude 26°45'N and longitude 94°12'E.

Details of the experiment. The experiment consisted of fifteen different *colocasia* genotypes, which were treated as individual treatments. Each treatment was replicated three times, resulting in a total of three repetitions. The size of each individual plot was 2.4 meters by 2.25 meters with spacing of 60 centimeters by 45 centimeters between plants.

To ensure optimal growth and yield, all recommended cultivation practices were followed throughout the experiment. The field experiment was organized using Randomized Block Design, with the genotypes randomly assigned to the blocks. This design helps minimize the impact of any external factors that could influence the results.

The detailed specifications of the experiment are provided below:

Design and layout

Location	Experimental Farm, Department of Horticulture, AAU, Jorhat
Variety	15
Replication	Three
Design of Experiment	Randomized Block Design (RBD)
Individual Plot Size	2.4 m × 2.25 m
Spacing	60 cm × 45 cm
Number of Plot	45
Time of planting	March, 2017

Morphological study. The morphological characterization of the taro cultivars was conducted using the descriptors developed by IPGRI (International Plant Genetic Resources Institute) in 1999. The vegetative data of the plants were recorded at 30-day intervals starting from the time of planting. These descriptors provide standardized framework for assessing and documenting the morphological traits of the taro cultivars under study. The petiole length, plant girth, no of leaf and petiole colour, leaf colour measurements were done in the monthly interval. The measurements in the study were conducted on the meristem of the third fully opened active leaves and the petioles from their base. For petiole measurement, the starting point was the ligulae (the basal part of the leaf) up to the base of the leaf. The observations and measurements of plant parts were performed using an eye lens thread and ruler to ensure accuracy. Additionally, digital photographs of the overall habit of the plants and specific plant parts were taken using Sony DSC-W230 digital camera.

Statistical analysis. The collected data was analyzed using the analysis of variance (ANOVA) for Randomized Block Design, following method proposed by Panse and Sukhatme (1985). The purpose of the ANOVA was to determine the sources of variation in the data and estimate the appropriate degrees of freedom for each factor.

The ANOVA model used in this analysis is as follows:

$$Yij = \mu + gi + vj + eij$$

Where, Yij represents the observed value of the response variable for the ith genotype in the jth replication.

μ represents the overall mean,

gi represents the effect of the ith genotype,

vj represents the effect of the jth replication,

eij represents the random error term associated with the ith genotype in the jth replication.

RESULTS AND DISCUSSION

Variation in plant habit. Significant differences were observed for all the plant growth characters among all the different taro genotype evaluated. Among all the cultivars of taro, petiole length at 120 DAP (Table 2) was recorded maximum in cultivar Moh-Khuti (127.13 cm) and it was on par with other cultivars *viz.*, Naga -2 (115.27 cm), Bor-Kachu (98.93 cm) and Kaka- Kachu (95.9 cm). While, minimum petiole length was recorded in Arunchal-7 (56.07 cm) and significant differences were noticed. Among all the cultivars of taro, plant girth at 150 DAP (Table 3) was recorded maximum in cultivar Moh-Khuti (17.48cm) and it was on par with other cultivars *viz.*, Bor-Kachu (17.17 cm), Kaka-Kachu (16.58cm) and AAU-col-46 (16.55). While, minimum plant girth was recorded in Red-Garo (13.21 cm) and significant differences were noticed among all the cultivars of taro. Number of leaves plant^{-1} at 150 DAP (Table 4) were recorded in cultivar Bor-Kachu (4.7) and it was on par with other cultivars *viz.*, Moh-Khuti (4.3), Ahina (4.0) and Kaka-Kachu (3.9). While, minimum number of leaves plant^{-1} was recorded in AAU-col-32 (2.9).

Colocasia is an important part in supplying substantial quantity of vegetable towards the daily need of the most people of eastern region of India. Among the growth attributes, greater petiole length and more number of leaves are preferable. The number of functional leaves at 30 days' interval differed significantly for the entire period of growth under each genotype. The number of functional leaves increased rapidly with different magnitude for different genotypes up to about 180 (DAP) days after planting which was observed Bor-Kachu followed by a gradual decline till maturity. This decline in number of leaves may be attributed to the diversion of the stored food materials for the production of cormel. Onwueme (1978) also reported that the shoot growth declines as result of reduction in leaf number, while studying the physiological factors controlling yield of tannia. Similar trend was reported by Sivam (1983).

Variation in leaf Characteristics. A variation among different taro genotypes based on leaf colour was observed. In this study different genotypes expressed (Table 5) green and dark green and light green leaf colour. MohKhuti, Ahina, Arunchal-7, Bor-Kachu, Boga-Ahina expressed light green colour. Koni-Kachu, Naga-2, Ghoti-Kachu, AAU-Col-46, expressed green colour. Red Garo, Garo, Karbi-Anglong, Kaka-Kachu, Domor-Dima, AAU-Col-32 expressed dark green colour. The variation observed in leaf colour among the taro cultivars can be attributed to multiple factors. One possible reason is the increased levels of chlorophyll A

and B, as mentioned in the work by Taiz and Zeiger (1991). These pigments are responsible for the green colouration in leaves and play crucial role in photosynthesis. Furthermore, the variation in leaf color can also be influenced by genetic factors. Leaf color is a trait that is genetically controlled and it serves as valuable characteristic for describing different genotypes, as highlighted in the research conducted by Lebot *et al*. (2010). Genetic variations in the expression of pigments and other related biochemical processes can lead to differences in leaf coloration among taro cultivars. In summary, the variation in leaf colour among taro cultivars can be attributed to both physiological factors, such as chlorophyll levels and genetic factors that control the expression of leaf colour.

Variation in petiole Characteristics. A variation among taro genotypes based on petiole was observed. In this study different genotypes expressed green and purple petiole colour. Red Garo, Ghoti-Kachu, Garo, Karbi-Anglong expressed purple colour. Whereas MohKhuti, Koni-Kachu, Naga-2, Kaka-Kachu Ahina, Domor-Dima. Arunchal-7, Bor-Kachu, AAU-Col-46, AAU-Col-32, Boga-Ahina genotypes expressed green petiole colour. The wide range of variation observed in various traits of *Colocasia esculenta* indicates the importance of conservation and research efforts for taro (Beyene, 2013, Vinutha *et al.*, 2015). It highlights the need for careful consideration and attention to preserving the diverse genetic resources of taro in the country.

Table 2: Petiole length (cm) at different days after planting.

Genotype	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	180 DAP	210 DAP
Red Garo	19.47	53.40	81.40	84.3	65.90	54.60	44.33
Moh Khuti	33.00	78.00	97.07	127.1	103.40	83.03	68.40
Koni Kachu	23.53	52.67	78.07	86.2	76.03	62.40	47.10
Naga -2	38.13	78.47	92.87	115.3	81.50	64.08	62.00
Kaka Kachu	31.27	72.33	83.30	95.9	71.93	61.97	48.88
Ghoti Kachu	28.67	74.20	79.20	93.0	56.80	50.17	32.60
Ahina	39.33	74.73	81.87	87.6	73.27	66.93	48.23
Domor Dima	21.07	49.80	65.27	72.9	60.30	66.67	64.03
Arunchal-7	29.33	56.53	71.67	56.1	53.93	72.80	46.07
Bor Kachu	30.60	71.20	86.00	98.9	87.03	71.13	59.12
AAU-Col-46	16.97	55.47	80.47	91.5	76.87	66.87	56.43
AAU-Col-32	25.23	58.93	80.13	89.4	65.87	58.47	44.97
Garo	29.47	71.67	81.33	88.5	72.00	57.47	47.83
Karbi Anglong	25.80	52.07	72.27	67.1	66.87	58.80	53.77
Boga Ahina	26.00	58.27	71.80	70.9	69.07	67.20	63.37
Mean	27.86	63.85	80.18	88.3	72.05	64.17	52.48
S.Ed(±)	3.97	6.69	4.10	11.098	7.82	10.35	10.39
CD5%	6.76	11.38	6.98	18.86	13.29	17.59	17.67

Table 3: Plant girth (cm) at different days after planting.

Genotype	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	180 DAP	210 DAP
Red Garo	6.05	11.81	12.01	12.39	13.21	11.50	9.85
Moh Khuti	8.37	13.65	14.69	16.85	17.48	14.32	13.34
Koni Kachu	7.06	12.86	13.62	14.54	15.86	11.88	9.32
Naga -2	9.11	11.67	12.83	14.65	15.98	12.52	10.20
Kaka Kachu	8.41	12.52	14.09	15.58	16.58	12.64	11.12
Ghoti Kachu	7.59	10.57	12.59	13.15	14.74	11.45	10.52
Ahina	8.51	12.25	13.85	14.58	15.86	11.89	10.15
Domor Dima	8.13	10.93	13.08	14.59	16.13	11.81	9.82
Arunchal-7	8.91	10.89	12.34	13.86	15.98	11.85	9.75
Bor Kachu	9.01	12.25	14.15	16.48	17.17	13.96	11.89
AAU-Col-46	8.85	12.16	14.16	15.58	16.55	12.15	9.85
AAU-Col-32	8.08	11.80	12.43	13.74	14.85	10.82	9.14
Garo	8.86	12.52	13.86	14.57	15.89	12.25	9.33
Karbi Anglong	8.08	11.55	12.78	13.53	14.58	13.13	10.85
Boga Ahina	7.93	10.55	12.46	14.25	15.22	10.29	9.15
Mean	8.20	11.86	13.26	14.56	15.74	12.16	10.29
S.Ed(±)	0.007	0.007	0.006	0.007	0.006	0.007	0.007
CD5%	0.013	0.013	0.010	0.012	0.011	0.012	0.011

Table 4: Number of leaves per plant at different days after planting.

Genotype	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	180 DAP	210 DAP
Red Garo	2.00	3.27	2.87	2.53	3.13	2.47	2.27
Moh Khuti	2.47	4.07	3.40	3.13	4.33	3.47	3.13
Koni Kachu	2.20	4.00	3.53	3.27	3.27	2.93	2.53
Naga -2	2.33	4.00	3.60	2.80	3.60	3.00	2.93
Kaka Kachu	2.20	4.40	3.60	3.00	3.87	3.13	2.67
Ghoti Kachu	2.27	4.07	3.60	2.73	3.67	2.80	2.87
Ahina	2.67	3.93	3.47	3.00	4.00	3.20	3.13
Domor Dima	2.27	4.00	3.07	3.20	3.73	3.20	3.00
Arunchal-7	2.33	3.07	2.73	2.53	3.60	3.33	2.73
Bor Kachu	2.73	5.47	3.67	3.07	4.67	4.00	3.93
AAU-Col-46	1.67	3.20	3.13	2.47	3.40	2.33	2.07
AAU-Col-32	2.07	3.67	3.00	2.27	2.93	2.60	3.00
Garo	2.20	4.40	3.20	3.40	3.60	3.40	2.73
Karbi Anglong	2.07	3.20	3.20	3.07	3.47	2.73	2.93
Boga Ahina	2.40	3.27	3.00	3.00	3.80	3.07	2.80
Mean	2.26	3.87	3.27	2.90	3.67	3.04	2.85
S.Ed(±)	0.20	0.34	0.27	0.28	0.29	0.23	0.26
CD5%	0.34	0.57	0.46	0.48	0.50	0.39	0.45

Table 5: Variation in petiole colour and leaf colour their different taro cultivars.

Genotypes		Morphological Traits	
		Petiole colour	Leaf colour
1.	Red Garo	Purple	Dark green
2.	MohKhuti	Green	Light green
3.	Koni-Kachu	Green	Green
4.	Naga -2	Green	Green
5.	Kaka Kachu	Green	Dark green
6.	Ghoti-Kachu	Purple	Green
7.	Ahina	Green	Light green
8.	Domor-Dima	Green	Dark green
9.	Arunchal-7	Green	Light green
10.	Bor-Kachu	Green	Light green
11.	AAU-Col-46	Green	Green
12.	AAU-Col-32	Green	Dark green
13.	Garo	Purple	Dark green
14.	Karbi-Anglong	Purple	Dark green
15.	Boga-Ahina	Green	Light green

Fig. 1. An overview of experimental field AAU, Jorhat, Assam.

CONCLUSIONS

This study addressed the existing knowledge gap by providing comprehensive information on morphology of fifteen varieties of *Colocasia esculenta* var. *stolonifera* found in the northeastern state of India. Prior to this research, there was lack of detailed morphological data on these varieties. Furthermore, the study presented compelling evidence that indicates close relationship between *C. esculenta* var. *stolonifera* and *C. esculenta var. esculenta*. The findings of the study also identified specific diagnostic characters for distinguishing Moh-Khuti and Ghoti-Kachu, two particular varieties within the species. Conspicuous diagnostic characters observed in the petiole length was highest (103.40±68.40cm) in Moh-Khuti, whereas the least was Ghoti-Kachu (56.80±32.60cm). The plant girth ranged from 17.48cm (Moh-Khuti) to 13.28cm (Red Garo), while the number of leaves ranged from (4.67) Bor-Kachu and least AAU-Col-32 (2.93). This study has provided valuable information regarding diagnostic and differential morphological characters that can aid in the identification and description of various varieties of *C. esculenta*. Notably, it was found that the cultivar Bor-Kachu exhibited the maximum number of leaves per plant followed by Moh-Khuti and Ahina. Additionally, Moh-Khuti displayed the longest petiole length with Naga-2 following closely behind. Plants are typically categorized into groups based on their similarities and differences in various traits including petiole length, plant girth, number of leaves, leaf color and petiole colour. These distinctive morphological characteristics play significant role in the classification and taxonomy of *Colocasia* varieties. By providing additional morphological information, this study contributes to resolving the ongoing controversies in the taxonomy of *Colocasia*. The obtained data can potentially aid in the delimitation of *C. esculenta* by facilitating the identification and differentiation of specific varieties within the species.

Acknowledgment. The scope of *Colocasia* in north east India have much diversity in different morphological characters and nutritional value which is needs for identification of best performing variety. The authors gratefully acknowledge the advisory committee and faculty members of the Department of Horticulture, Department of Crop Physiology and Department of Plant Breeding and Genetics at Assam Agricultural University for their valuable support and encouragement throughout the study. Their guidance played a crucial role in ensuring the successful completion of this research. The authors also extend their sincere appreciation to the taro farmers of North East India for their cooperation and willingness to provide the cultivars used in this study. Their contribution was essential in obtaining the necessary plant materials and conducting the research effectively.

Conflict of Interest. None.

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