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Performance Analysis of Selected Taro Cultivars in Kerala State of India

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Abstract

Taro (*Colocasia esculenta* (L.) Schott) is an important tuber crop that belongs to the plant family Araceae. Taro tubers are rich in starch, minerals and vitamins. Taro plays an important role in hunger management. Tubers and leaves of taro possess antimicrobial, anti-cancerous, antidiabetic and immunostimulatory properties, and thus it is a pharmacologically important crop species. Different cultivars of taro are cultivated in different parts of the world. Analysis of naturally occurring germplasm is the first step in plant breeding experiments. The present study involves the analysis of growth and yield attributes of five taro cultivars (CULT 1, CULT 2, CULT 3, CULT 4 and CULT 5) from Kerala state of India. Data on twenty-two characters, including eight growth characters and fourteen yield characters, were analysed. Identification and selection of potentially useful cultivars of a crop species is an important step to maintain food security. Based on the cumulative performance index, CULT 5 ranked first, followed by CULT 2 and CULT 3. We can adopt these elite cultivars for extensive cultivation. Future plant breeding initiatives can use these outstanding cultivars to develop potential taro varieties.

Introduction

Colocasia esculenta (L.) Schott, commonly known as taro, belongs to the plant family Araceae. Taro is a nutritionally and pharmacologically important tuber crop, domesticated in ancient times.[1] The two primary categories of taro cultivars are dasheen and eddoe varieties. The eddoe variety has several cormels and a small corm, while the dasheen type has a large corm and a few cormels.[2,3] Intermediate varieties with the combinations of eddoe and dasheen characters also exist in natural populations.

Studies show that taro originated in tropical region that is spanning from India to Indonesia.[4] Hence, high diversity of taro is expected in this area at the intraspecific level. African and Asian countries

contribute more than 90% of the world's taro production. During the period from 2018 to 2022, there was a 5% (843,940.98 ton) increase in global taro production.[5] In India, major taro producing states include Kerala, Tamil Nadu, Andhra Pradesh, Telangana, Madhya Pradesh, Orissa, Uttar Pradesh, Bihar, Assam, Meghalaya and West Bengal.[6,7]

Taro flour is a gluten-free food with high carbohydrate content.[8] Hence, it is a good alternative for people suffering from gluten-related diseases like non-Celiac gluten sensitivity (NCGS) and Celiac disease (CD), which require a gluten-free diet.[9,10] Taro corms also exhibit anticancerous, antidiabetic and immunostimulatory properties. Consumption of taro tubers helps to fight against diseases and infections.[11]

Taro corm contains 20-35% starch on a fresh weight basis and 81% on a dry weight basis.[12,13] Taro leaves are rich in protein and act as a source of essential amino acids. Taro leaves also contain minerals like potassium, iron, phosphorous, magnesium and zinc.[14,15]

Taro is important in hunger management because it alleviates hunger and addresses nutrient deficiency of many people in the world.[16] Nowadays, the world population is growing rapidly, but at the same time, agricultural land area is decreasing. Climate change is also becoming a new threat. Alleviating world hunger has become a massive task.

New high-yielding, nutrient-rich, stress-tolerant, disease and pest-resistant crop plants can be developed through different methods like plant breeding or genetic engineering. Naturally available and potentially useful germplasm of the crop species is the basis of all these plant breeding programs. The availability of suitable germplasm has a major impact on the success rate of plant breeding efforts. Therefore, it is very important to explore and charac-terise naturally available germplasm accessions.

Taro is an underutilized and underexploited tuber crop even though it is a nutritionally rich and cost-effective food source. Only a little research has been done on taro at the intraspecific level. In addition, the characterisation of naturally available germplasm is a preliminary step to conserve the genetic diversity

of crop species. The major aim and objectives of the present study include analysis of growth and yield characters of five taro cultivars of Kerala state of India and their performance analysis.

Materials and Methods
Five different cultivars of taro (CULT 1, CULT 2, CULT 3, CULT 4 and CULT 5), cultivating in the Kerala state of India, were selected for the current study. The experiment was carried out under uniform conditions in the experimental net house of the Department of Botany and Research Centre, Govt. Brennen College, Thalassery, Kannur District, Kerala, India.

The experiment was laid out in randomised block design (RBD) with 3 replications and 18 plants per plot. Taro seed tubers were collected directly from farmers and taken as the base material for the experiment. The experiment was carried out during the crop season 2023-2024. Taro seed tubers were planted during the third week of May. Planting, manuring, weeding, and earthing up were done in accordance with the package of cultivation practices recommended by Kerala Agricultural University. Twenty-two characters, including both plant growth and yield characters, were recorded and analysed. Mean values for each character for each cultivar were found out. The significance of the difference between cultivar means was tested statistically through analysis of variance (ANOVA). The F and P values of each character were determined and compared with the standard F table and alpha P value of 0.01.[17] To determine the significance of the variation in cultivar means, the Critical Difference value was also computed.

Performance indices were computed for each agronomic character as per the following equation.[18] Then cumulative performance index was calculated, and overall performance of all cultivars was analysed.

Performance index = Accession mean of the character/Grand mean of the character

In the case of sinus width and sinus length, reciprocal of the above formula was used since short sinus width and sinus length are desirable characters.

Performance index = Grand mean of the character/Accession mean of the character

Results and Discussion

Twenty-two characters of five native taro cultivars were statistically analysed in this study (Table 2 and Table 3). There is highly significant variation among these five cultivars, according to the P-value for each character (P < 0.01). Based on the F-value, all characters exhibit considerable variation at the 1% level of significance, with the exception of secondary cormels length. The length of secondary cormel was significant at 5% significance level. Morphological characteristics of five taro cultivars are listed in Table 1.

Table 1: Morphological characteristics of taro cultivars.

Cultivar Character		CULT 1	CULT 2	CULT 3	CULT 4	CULT 5
Leaf blade colour		Green	Green	Green	Purple green	Green
Leaf blade margin		Green	Green	Purple	Purple	Green
Petiole junction colour		Green	Green	Purple	Purple	Green
Petiole colour	Top	Light green	Light green	Light purple	Purple green	Light green
	Middle	Green	Green	Purple brown	Blackish purple	Light purple brown
	Basal	Green	Green	Purple brown	Blackish purple	Purple brown
Arrangement of primary cormels		Sparsely budding	Densely budding	Densely budding	Sparsely budding	Sparsely budding
Corm shape		Round	Round	Conical	Conical	Conical
Corm cortex colour		Light purple	White	White	Purple	Light purple
Corm central part colour		White	White	White	White	White
Shape of cormels		Elongated and bulged at one end.	Obovate	Obovate	Round to obovate	Obovate

The comparative performance of eight growth characters, including plant height, number of leaves, number of suckers, petiole length, leaf lamina length, lamina width, sinus depth and sinus width were analysed (Table 4). CULT 4 possess highest performance index for the character plant height. In CULT 4, average plant height was 107.28±4.13 cm. Plant height was minimum in CULT 2 (78.04±2.45 cm). Maximum number of leaves seen in CULT 3 followed by CULT 4. CULT 5 is characterised by the least number of leaves. At the same time, leaf lamina length and leaf lamina width were maximum in CULT 5.

Among five cultivars, the longest petiole was observed in CULT 4 (104.54±4.31 cm) followed by CULT 5 (103.14±3.33 cm) and the smallest petiole in CULT 2 (81.47±2.13 cm). Taro leaves and petioles are rich in fiber, minerals, protein and vitamins like vitamin C, vitamin B1, vitamin B2 and vitamin B3.[19,20] Taro leaves and petioles also contain anti-nutrients like calcium oxalate, which can be eliminated through appropriate processing methods, thereby allowing the leaves and petioles to be used as vegetables.

The number of suckers was minimum in CULT 1 and maximum in CULT 3. Prior studies revealed a strong positive correlation between tuber yield and the number of suckers in taro.[21,22] Photosynthetic area of taro leaves decreases with increase in sinus width and sinus depth. Hence, short sinus width and sinus length are desirable characters in the case of taro. Sinus width and sinus length were minimum in CULT 3 and maximum in CULT 4.

Fourteen yield characters, including total yield, corm fresh weight, cormels fresh weight, corm length, corm thickness, number of primary, secondary and tertiary cormels, length of primary, secondary and tertiary cormels and thickness of primary, secondary and tertiary cormels, were recorded and statistically analysed (Table 3). Based on yield characteristics, the comparative performance of each cultivar was analysed (Table 4).

Table 2: Mean value of growth characters of five taro cultivars.

Growth Characters	CULT 1	CULT 2	CULT 3	CULT 4	CULT 5	Grand mean of the character	P value	CD @ 5%	CD @ 1%
Plant height (cm)*	89.48±2.54	78.04±2.45	85.66±3.25	107.28±4.13	104.57±3.22	93.01	1.1×10^{-8}	3.37	4.8
Number of leaves *	4.72± 0.16	5.22± 0.13	7.33± 0.2	5.39± 0.14	4±0	5.33	4.3×10^{-7}	0.49	0.7
Number of suckers *	0.06± 0.06	0.56± 0.12	1± 0.23	0.89± 0.18	0.78± 0.15	0.66	0.00032	0.32	0.45
Petiole length (cm)*	89± 3.66	81.47±2.13	86.39±3.1	104.54±4.31	103.14±3.33	92.91	1.34×10^{-7}	3.53	5.04
Leaf lamina length (cm)*	34.86±1.31	36.86±0.73	30.48±1.22	37.8± 1.54	43.55±1.7	36.71	6.11×10^{-6}	2.77	3.96
Leaf lamina width (cm)*	26.56±1.27	26.34±0.52	20.18±0.77	29.73±1.45	37.23±1.27	28.01	0.0002	3.37	4.82
Sinus depth (cm)*	5.26± 0.13	5.9±0.11	4.42± 0.18	7.13± 0.32	5.72± 0.19	5.69	4.12×10^{-8}	0.29	0.42
Sinus width (cm)*	12.32±0.45	9.66± 0.29	7.52± 0.38	13.23±0.51	10.29±0.18	10.6	1.93×10^{-5}	1.33	1.9

*F-value significant at 1% significance level.

Table 3: Mean value of yield characters of five taro cultivars.

Yield Characters	CULT 1	CULT 2	CULT 3	CULT 4	CULT 5	Grand mean	P value	CD @ 5%	CD @ 1%
Corm fresh weight (g)*	45.89±5.63	62.17±3.59	50.78±2.95	126.78±12.03	135.61±8.3	84.25	2.05×10^{-6}	14.33	20.45
Cormel fresh weight (g)*	91.44±14.51	162.28±15.15	114.61±10.27	77.33±5.89	183.22±14.11	125.78	0.0001	22.45	32.04
Corm length (cm)*	4.19± 0.14	4.24± 0.14	4.86± 0.16	9.89± 0.67	5.8± 0.17	5.8	5.4×10^{-10}	0.47	0.67
Corm thickness (cm)*	3.79± 0.19	4.6± 0.14	3.87± 0.09	4±0.19	5.68± 0.13	4.39	3.15×10^{-6}	0.38	0.54
No. of primary cormels*	4.61± 0.28	4.89± 0.33	5.78± 0.34	2.72± 0.23	6.22± 0.32	4.84	0.0001	1	1.43
No. of secondary cormels *	5.56± 0.78	5.17± 0.53	4.89± 0.69	0.61± 0.24	3.67± 0.32	3.98	3.21×10^{-6}	0.97	1.39
No of tertiary cormels*	0.17± 0.09	1.11± 0.31	0.94± 0.3	0±0	0.17± 0.09	0.48	0.0002	0.41	0.59
Primary cormel length (cm)*	8.36± 0.81	4.76± 0.24	3.62± 0.18	4.37± 0.28	4.77± 0.28	5.18	6×10^{-5}	1.23	1.76
Primary cormel thickness (cm)*	1.65± 0.08	2.6± 0.06	2± 0.06	2.53± 0.16	2.87± 0.08	2.33	6.45×10^{-5}	0.33	0.48
Secondary Cormel length (cm)	2.76± 0.28	2.76± 0.17	3.64± 0.29	3.12± 0.29	2.25± 0.21	2.91	0.01	0.50	0.71
Secondary Cormel thickness (cm)*	1.38± 0.07	2.34± 0.08	1.94± 0.05	1.72± 0.11	2.04± 0.12	1.88	5.99×10^{-5}	0.24	0.34
Tertiary cormel length (cm)*	1.36± 0.02	2.01± 0.17	2.15± 0.08	0±0	1.5± 0.02	1.4	0.0001	0.7	1
Tertiary Cormel Thickness (cm)*	1.42± 0.08	2.06± 0.09	1.79± 0.06	0±0	1.87± 0.01	1.43	9.07×10^{-7}	0.36	0.51
Total Yield (g)*	137.33±15.48	224.44±18.17	165.39±12.49	206.33±16.61	318.83±20.45	210.47	2.00×10^{-8}	19.84	28.32

*F-value significant at 1% significance level.

Table 4: Performance index of five taro cultivars.

Growth and Yield Character	CULT 1	CULT 2	CULT 3	CULT 4	CULT 5
Plant height	0.96	0.84	0.92	1.15	1.12
Number of leaves	0.89	0.98	1.37	1.01	0.75
Number of suckers	0.09	0.85	1.52	1.35	1.19
Petiole length	0.96	0.88	0.93	1.13	1.11
Leaf lamina length	0.95	1.00	0.83	1.03	1.19
Lamina width	0.95	0.94	0.72	1.06	1.33
Sinus depth	1.08	0.96	1.29	0.8	0.99
Sinus width	0.86	1.1	1.41	0.8	1.03
Corm fresh weight	0.54	0.74	0.6	1.5	1.61
Cormel fresh weight	0.73	1.29	0.91	0.61	1.46
Corm length	0.72	0.73	0.84	1.71	1
Corm thickness	0.86	1.05	0.88	0.91	1.29
No. of primary cormels	0.95	1.01	1.19	0.56	1.28
No. of secondary cormels	1.4	1.3	1.23	0.15	0.92
No. of tertiary cormels	0.36	2.32	1.97	0	0.36
Primary cormel length	1.62	0.92	0.7	0.84	0.92
Primary cormel thickness	0.71	1.12	0.86	1.09	1.23
Secondary Cormel length	0.95	0.95	1.25	1.07	0.77
Secondary Cormel thickness	0.73	1.24	1.03	0.91	1.08
Tertiary cormel length	0.97	1.43	1.53	0	1.07
Tertiary Cormel Thickness	0.99	1.44	1.25	0	1.31
Total Yield	0.65	1.07	0.79	0.98	1.51
Cumulative PI	**18.92**	**24.16**	**24.02**	**18.66**	**24.52**
RANK	IV	II	III	V	I

CULT 5 produced the highest total yield, followed by CULT 2 and CULT 4. Corm fresh weight and cormel fresh weight were also maximum in CULT 5 (135.61±8.3 gm and 183.22±14.11 gm, respectively). Corm fresh weight was minimum in CULT 1, and cormel fresh weight was minimum in CULT 4. Length and width of leaf lamina and petiole length show a significant positive correlation with total yield.[23] High petiole length, leaf width and leaf length of CULT 5 also may have contributed to its best overall yield.

Corm thickness and number of primary cormels were maximum in CULT 5, while corm length was maximum in CULT 4. Maximum number of secondary cormels observed in CULT 1. Meanwhile, CULT 2 possesses the highest number of tertiary cormels. Previous studies indicate a positive correlation between the number of cormels and the total yield of taro.[24,25]

CULT 5 shows the highest primary cormel thickness with a mean value of 2.87 ± 0.08 cm. The lengths of secondary and tertiary cormels were maximum in CULT 3, while their thicknesses were maximum in CULT 2.

The performance of five taro cultivars were analysed based on the performance index calculated for twenty-two characters of taro. Out of these five taro cultivars, CULT 5 ranked first based on the cumulative performance index. Maximum cormel fresh weight, corm fresh weight, total yield, corm thickness, number of primary cormels and thickness of primary cormels were reported in CULT 5. CULT 2 comes in the second position, followed by CULT 3. The number of tertiary cormels, thickness of secondary cormels and thickness of tertiary cormels were maximum in CULT 2. CULT 1 ranked fourth and CULT 4 ranked fifth. The elite cultivars mentioned in this study can be popularised among farmers for extensive cultivation. Future plant breeding projects can utilise these cultivars to produce promising taro varieties.

Conclusion

The development of high-yielding varieties and utilisation of naturally available germplasm of crop species are the key methods to overcome hunger and malnutrition. Growth and yield characteristics of five traditional taro cultivars were analysed in this experiment. Highly significant variation exists among these five cultivars. Taro cultivars were ranked based on the cumulative performance index. Among these five cultivars, CULT 5 ranked first, followed by CULT 2 and CULT 3. Maximum cormel fresh weight, corm fresh weight, corm thickness, number of primary cormels and primary cormel thickness were reported in CULT 5. CULT 5 also exhibited the highest leaf breadth and length. In the case of total yield, CULT 2 comes in the second position. Elite cultivars mentioned in this study can be utilised for large-scale cultivation and future plant breeding experiments.

Conflict of Interest

The authors do not have any conflict of interest.

Data Availability Statement

All data underlying this study are available as part of the article and no additional source data are required.

Ethics Statement

This research did not involve human participants, animal subjects, or any material that requires ethical approval.

Author Contributions

- **Aiswarya Thekkayil:** Primary investigator. Participated in exploration of genetic resources, cultivation of taro plants, data collection and data analysis. Writing – Original Draft.
- **Sumisha Chennappoyil and Swedha Madhavan Mavally:** Participated in exploration of genetic resources and data collection.
- **Chandramohanan Kotten Thazhath:** Conceptualization and supervision of the study.

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