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Short Communication

Evaluation of colocasia (*Colocasia esculenta* L.) genotypes for yield and quality attributes under natural farming conditions

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Abstract

The investigation was conducted during *Kharif*, 2020 at Research Farm of Research Sub Station Berthin, District Bilaspur, Himachal Pradeshin which 26 genotypes, collected within and outside the state were evaluated for yield and quality attributes in a Randomized Complete Block Design (RBD) with 3 replications. The promising genotypes identified based on mean performance for yield and quality attributes are LC-10 (collection from Baijnath of district Kangra, HP)was found best for highest total yield, cormel yield, cormel diameter, corm yield, number of cormels /plant, sugar and starch content (7 characters) followed by LC-15 (collection from Kolar of district Sirmour, HP)for total yield, cormel yield, cormel diameter, corm yield, crude protein and lowest oxalate content (6characters); LC-8 (collection form Gagret, Tehsil Amb of district Una, HP)recorded highest total yield, cormel yield, number of cormels /plant and total polyphenols (4 characters); LC-14(collection from Sarkaghat of district Mandi, HP) for total yield, cormelyield andnumber of cormels /plant (3 characters), LC-9 (collection from Village Bassi of district Mandi) for total yield, cormel yield and total polyphenols (3 characters). Based on the performance of these genotypes, they can be utilized as source of germplasm in colocasia improvement program under natural farming conditions.

Key words: Colocasia, corm yield, cormel, quality attributes, natural farming

Among aroids, colocasia (*Colocasia esculenta* L.) commonly known as taro or arvi has about 1000 recognized cultivars, but most of them fall into two groups; the eddoe type i.e., *Colocasia esculenta* var. *Esculenta* (has relatively small mother corm surrounded by large well developed cormels) and second one is dasheen i.e., *Colocasia esculenta* var. *antiquorum* (which has a large central corm along with fewer, smaller and more compactly clustered cormels). Although, it is more generally accepted that the taros are polymorphic species of *C. esculenta*. It is perennial, cormous plant, normally 0.4 to 2.3 m tall, with large heart shaped leaves arising from an underground, farinaceous corm, surrounded by a number of secondary corms or cormels, which also vary greatly in size and shape (George *et al*., 2012). It is cultivated as a vegetable crop in India, Burma, China, Hawaii, Fiji and many South East Asian countries. Its chromosome number is 2n = 2x = 28 and is believed to be originated in South-East Asia including India and Malaysia (Purseglove, 1972). It is grown throughout the tropics and subtropics for its corm, cormels and leaves, which serves as staple source of diet for people around the world. It is considered as staple source of diet and is 14th most consumable vegetableall over the world (Rao *et al*., 2010).

In Asia, it is grown in an area of 135 thousand hectares with an annual production of 2,273 thousand metric tonne (Anonymous, 2017). In India, it is quite popular in most of the states, especially Kerala, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal and North-East states. In Himachal Pradesh, under low and mid hill conditions, it is grown by more than 80 % of farm families even on small scale due to its local preference for consumption as vegetable, pickle, used in kadi, leaf roll and nuggets etc. The versatility of this crop is reflected by the fact that not only the corm but also the petiole and leaf are used as vegetable. A lot of genetic variability among colocasia genotypes is available within the state. Since it is propagated vegetatively, hence the available germplasm breeds true. These genotypes are mostly grown under organic/ natural farming condition and are well adapted to the local farming conditions of respective area.

It is rich source of starch, carbohydrates, proteins, vitamin A, C and minerals like Ca, Fe and P with its starch digestibility is as high as 98 % (Vinning, 2003). All parts of the plant including corm, cormels, stalk, leaves and flowers are edible and contain abundant starch (Bose *et al*., 2003). Its corms and leaves are also credited with having medicinal values and are used to reduce tuberculosis, ulcers, pulmonary congestion and fungal infection. The acridity of tubers and leaves is due to presence of calcium oxalate. Calcium oxalate content in tubers and the leaves varies from variety to variety (Asokan *et al*., 1980). The oxalic acid content in tubers and leaves plays an important role in consumer's acceptability as tuber and leafy vegetable. The consumer's preference is for the varieties having less acridity.

In modern agricultural practices, farmers are using chemical fertilizers on a large scale to improve crop productivity. The continuous and excess use of chemical fertilizers over a long period of time has led to contamination of food products, environmental pollution, soil fertility depletion and also increase the cost of cultivation. Soil micro-organisms play a very important role in improving soil fertility not only because of their ability to carry out bio-chemical transformations but also due to their importance as a source of sink for mineral nutrients (Jenkinson and Ladda, 1981). Several groups of microorganisms have the potential to enhance growth and improve the health of crops. Under Subhash Palekar Natural Farming (SPNF), soil is supplemented with microbial consortium like *Beejamrit* and *Jeevamrit* to accelerate the proliferation of soil microflora which is beneficial for soil enrichment. *Jeevamrit* contains major nutrients like N, P, K and micro nutrients like Zn, Cu, Fe and Mn (Sreenivasa *et al*., 2011). *Beejamrit* was found to enhance corm germination and vegetative growth as it contains growth hormones and beneficial microflora (Palekar, 2006). The philosophy of natural farming is natural growth of beneficial microorganisms without using external manures, chemicals and pesticides; however, for the success of any crop, the role of varieties/genotypes adapted to local conditions and agronomical factors cannot be overlooked.

The present investigation was undertaken during *Kharif*, 2020 at Research Farm of Research Sub Station Berthin, District Bilaspur, Himachal Pradesh. The experimental material comprised of 26 colocasia genotypes, collected from within and outside the state for their evaluation under natural farming conditions. The experiment was laid out in Randomized Complete Block Design (RBD) with 3 replications of plot size 1.8 m ×1.8 mand spacing 45 cm x 45 cm. For raising the crop under organic farming conditions, 'Ad-hoc Guidelines' developed by the Department of Organic Agriculture and Natural Farming, CSKHPKV, Palampur were followed. All the genotypes were planted on 18th of June, 2020 and prior to planting, *ghanjeevamrit* @ 500 kg ha^{-1} was applied and incorporated in the plots. *Beejamrit* was used to treat corms @ 2 liters per 10 kg. Foliar application of *jeevamrit* was done after one month of planting of corms @ 5% followed by its four foliar application @ 10%, each after 21 days. Foliar application of fermented butter milk was done @ 2.5 % after 72 days of planting followed by its two sprays @ 5% at one month interval.

The data were recorded from five randomly selected plants per treatment foryield and quality attributes. For estimation of quality attributes, harvested corms were properly cleaned, peeled and sliced thinly. The slices were then kept in the oven for about 16 hours at 60^{0}C to remove moisture. The dehydrated corm slices were then powdered with the help of a grinder and then used for further biochemical analysis. It was used to determine starch (Hedge and Hofreiter, 1962), total sugars (Sadasivam and Manickam, 1992), oxalate content (AOAC, 1984), crude protein (AOAC, 2000), anthocyanin content (Rangana, 1986) and total phenols (Makkar, 2003). Then average was worked out and the data was analysed statisticallyby Panse and Sukhatme (1978). The results have been presented and discussed in following paragraphs.

Cormel attributes

Number of cormels per plant: Since Subhash Palekar Natural Farming (SPNF) improves the productivity of the soil, leading to healthy crop. The number of cormels per plant is one of the yield attributing character and were counted at the time of crop harvest after separation from mother crom. The range fornumber of cormels per plant varies from 2.00 to 7.93 and the mean value was 5.94 cormels per plant (Table 1). The genotype, LC-14 recorded highest number of cormels per plant (7.93) followed by LC-10 (7.80), LC-8 (7.60), LC-4 (7.53), LC-17 (7.53), LC-6 (7.40) and Muktakeshi (7.33), whereas, lowest in LC-9 (2.00). Genotypes LC-14, LC-10, LC-8, LC-4, LC-17, LC-6, Muktakeshi, LC-15, LC-13 and Rajindra-1 were at par with each other. These results are in proximity with the findings of Dwivedi and Sen (2001); Singh *et al*. (2003); Sinha *et al*. (2006) and Chadha *et al*. (2007).

Cormel length (cm): The cormel length ranged from 1.61 to 13.08 cm with mean value of 5.80 cm, respectively (Table 1). It was recorded highest in genotype LC-12 (13.08 cm) followed by LC-16 (8.87 cm), Rajindra-1 (7.25 cm) and LC-13 (7.03 cm) and were statistically superior to Muktakeshi (SC) *i.e.* 5.23 cm. None of the genotype was at par with LC-12. Among different genotypes, the lowest cormel length was recorded in genotype LC-9 (1.61cm). These

Table 1. Performance of colocasia genotypes for cormel attributes under natural farming conditions

Genotype	Number of cormels/plant	Cormel length (cm)	Cormel diameter (cm)
LC-1	6.07	6.53	1.85
LC-2	4.20	3.87	1.24
LC-3	3.80	4.13	1.40
LC-4	7.53	6.14	1.98
LC-5	4.33	4.59	1.44
LC-6	7.40	6.10	2.02
LC-7	5.60	2.91	1.87
LC-8	7.60	6.41	1.56
LC-9	2.00	1.61	1.09
LC-10	7.80	5.89	2.11
LC-11	6.13	5.68	1.99
LC-12	6.20	13.08	1.23
LC-13	6.93	7.03	1.55
LC-14	7.93	5.79	1.88
LC-15	7.07	4.76	2.50
LC-16	4.53	8.87	0.85
LC-17	7.53	6.52	1.36
LC-18	5.67	5.61	1.65
LC-19	5.40	5.05	1.31
LC-20	4.20	6.06	1.78
LC-21	5.27	6.28	2.19
LC-22	5.40	6.23	1.73
LC-23	6.07	5.31	1.72
LC-24	5.60	5.49	1.64
Rajindra-1	6.80	7.25	1.90
Muktakeshi (C)	7.33	5.23	1.26
Mean	5.94	5.80	1.62
Range	2.00- 7.93	1.61-13.08	0.85-2.50
CD (P=0.05)	1.38	1.41	0.22
CV (%)	14.22	14.7	8.09

results are in accordance with the work of Chadha *et al*. (2007); Angami *et al*. (2015) and Boampong *et al*. (2018).

Cormel diameter (cm): The cormel diameter was recorded highest in genotype LC-15 (2.50 cm) followed by LC-21 (2.19 cm), LC-10 (2.11 cm) and LC-6 (2.02 cm), whereas, lowest value recorded for LC-16 (0.85 cm). Among different genotypes under investigation, most of them were statistically superior to Muktakeshi (SC) except LC-2, LC-3, LC-5, LC-9, LC-12, LC-16, LC-17 and LC-19, whereas, none of the genotype was at par with LC-15. The range value for cormel diameter varied from 0.85 to 2.50 cm and the mean value was 1.62 cm. These findings are in line with Ghosh *et al*. (2004); Chadha *et al*. (2007) and Cheema *et al*. (2007).

Yield attributes

Cormel yield per plant (g) and per hectare (q): Cormel yield per plant and per hectare ranged from 20.00 to 186.53 g/plant and 9.00 to 83.94 q/ha with mean values of 91.92 g/plant and 41.36 q/ha, respectively (Table 2). It was highest in LC-10 (186.53 g/plant, 83.94 q/ha) followed by LC-14

Table 2. Performance of colocasia genotypes for yield attributes under natural farming conditions

Genotype	Cormel yield		Corm yield		Total yield (Corm + Cormel, q/ha)
	per plant (g)	per ha (q)	per plant (g)	per ha (q)	
LC-1	85.47	38.46	87.93	39.57	78.03
LC-2	64.80	29.16	59.00	26.55	55.71
LC-3	58.80	26.46	29.80	13.41	39.87
LC-4	96.27	43.32	67.60	30.42	73.74
LC-5	59.73	26.88	69.53	31.29	58.17
LC-6	120.00	54.00	60.27	27.12	81.12
LC-7	89.60	40.32	77.07	34.68	75.00
LC-8	128.20	57.69	55.87	25.14	82.83
LC-9	20.00	9.00	163.2	73.44	82.44
LC-10	186.53	83.94	98.27	44.22	128.16
LC-11	95.33	42.90	65.00	29.25	72.15
LC-12	112.13	50.46	32.87	14.79	65.25
LC-13	97.93	44.07	60.13	27.06	71.13
LC-14	134.27	60.42	71.47	32.16	92.58
LC-15	120.73	54.33	72.33	32.55	86.88
LC-16	44.33	19.95	25.60	11.52	31.47
LC-17	106.20	47.79	51.13	23.01	70.80
LC-18	71.53	32.19	45.07	20.28	52.47
LC-19	60.07	27.03	45.07	20.28	47.31
LC-20	104.33	46.95	36.33	16.35	63.30
LC-21	117.80	53.01	61.87	27.84	80.85
LC-22	69.40	31.23	62.00	27.90	59.13
LC-23	109.33	49.20	59.93	26.97	76.17
LC-24	91.27	41.07	51.67	23.25	64.32
Rajindra-1	85.53	38.49	83.07	37.38	75.87
Muktakeshi (C)	59.73	26.88	48.80	21.96	48.84
Mean	91.92	41.36	63.11	28.40	69.76
Range	20.00- 186.53	9.00- 83.94	25.60- 163.20	11.52- 73.44	31.47- 128.16
CD (P=0.05)	17.89	8.05	14.05	6.32	8.98
CV (%)	11.86	11.86	13.58	13.58	7.85

(134.27 g/plant, 60.42 q/ha) and LC-8 (128.20 g/plant, 57.69 q/ha), whereas, lowest in LC-9 (20.00 g/plant, 9.00 q/ha). Most of genotypes were statistically superior to Muktakeshi (SC) except LC-2, LC-3, LC-5, LC-9, LC-16, LC-18, LC-19 and LC-22. These results are in accordance with the work of Dwivedi and Sen (1998); Dwivedi and Sen (2001); Singh *et al*. (2003) and Rao and Lakshmi (2012).

Corm yield per plant (g) and per hectare (q): After separation of cormel, corm yield per plant and per hectare was recorded. The range for corm yield per plant and per hectare varied from 25.60 to 163.20 g/plant and 11.52 to 73.44 q/ha, whereas, mean value recorded was 63.11 g/plant and 28.40 q/ha (Table 2). The corm yield was recorded highest in genotype LC-9 (163.20 g/plant, 73.44 q/ha) followed by LC-10 (98.27 g/plant, 44.22 q/ha) and LC-1 (87.93 g/plant, 39.57 q/ha), whereas, it was lowest in LC-16 (25.60 g/plant, 11.52 q/ha). Genotypes LC-9, LC-10, LC-1, LC-7, LC-15, LC-14, LC-5 and LC-4 were found statistically higher for corm yield when compared with Muktakeshi used as standard check. These findings are similar with Dwivedi and Sen (1998); Dwivedi and Sen (2001); Singh *et al*. (2003) and Cheema *et al*. (2007) as they reported that corm/cormel yield varied with germplasm.

Total yield (q/ha): The total yield is the sum total of corm as well as cormel yield. The range and mean values of genotype investigated varied from 31.47 to 128.16 q/ha and 69.76 q/ha, respectively (Table 2). Genotype LC-10 recorded highest value (128.16 q/ha) followed by LC-14 (92.58 q/ha) and LC-15 (86.88 q/ha). Among different genotypes investigated, most of them except LC-2, LC-3, LC-16, LC-18 and LC-19 were statistically superior to Muktakeshi (SC) *i.e*. 48.84 q/ha. These results are similar to those reported by Singh *et al*. (1995) and Dwivedi and Sen (1998).

Quality attributes: Crude protein content was recorded significantly higher in LC-3 (8.90 %) as compared to Muktakeshi (8.41%), which was the second highest for the trait while anthocyanin significantly highest in genotypes, LC-24, LC-20, LC-15, LC-19, LC-5, LC-6, LC-12, LC-17, LC-23, LC-18, LC-11, LC-7, LC-22, LC-4 and LC-3 when compared to Muktakeshi, used as standard check (Table 3).

Table 3. Performance of colocasia genotypes for quality attributes under natural farming conditions

Genotype	Crude protein (%)	Anthocyanin content (mg/100g)	Oxalate content (%)	Starch (%)	Total sugar (%)	Total phenol (mg/100g)
LC-1	8.35	2.23	0.215	73.22	14.75	1.40
LC-2	8.08	2.17	0.145	24.13	9.30	7.97
LC-3	8.90	2.54	0.252	38.84	14.26	7.87
LC-4	5.37	2.55	0.185	52.93	14.25	8.02
LC-5	6.80	3.37	0.180	71.81	13.59	6.88
LC-6	6.30	3.12	0.189	25.29	12.86	2.19
LC-7	6.95	2.74	0.195	73.88	14.71	7.33
LC-8	5.11	2.41	0.223	25.22	10.57	7.93
LC-9	5.98	2.16	0.201	20.18	8.12	7.94
LC-10	8.26	2.38	0.198	71.52	14.38	6.63
LC-11	5.43	2.81	0.277	13.08	8.43	7.35
LC-12	4.76	3.49	0.433	37.72	14.41	7.35
LC-13	4.03	3.44	0.531	39.82	13.30	5.60
LC-14	4.61	2.88	0.397	13.70	10.17	3.48
LC-15	6.19	4.09	0.122	15.40	10.23	3.36
LC-16	7.06	2.86	0.369	25.22	12.37	3.35
LC-17	4.93	3.49	0.265	37.25	13.89	8.00
LC-18	6.28	3.37	0.132	23.12	12.30	6.31
LC-19	7.09	3.82	0.333	72.79	14.67	6.97
LC-20	7.33	4.24	0.369	38.51	8.28	4.48
LC-21	6.63	2.12	0.248	20.51	10.48	5.58
LC-22	5.75	2.63	0.252	14.02	6.62	6.16
LC-23	5.81	3.05	0.291	58.55	12.01	5.69
LC-24	6.30	5.25	0.239	14.24	11.88	7.20
Rajindra-1	7.91	2.32	0.197	29.46	12.83	7.37
Muktakeshi (C)	8.41	2.29	0.201	49.35	13.40	4.95
Mean	6.49	2.99	0.26	37.68	12	6.05
Range	4.03- 8.90	2.12- 5.25	0.122- 0.531	13.08-73.88	6.62-14.75	1.40-8.02
CD (P=0.05)	0.33	0.20	0.02	2.90	0.48	0.22
CV (%)	3.13	4.02	4.6	4.69	2.42	2.26

Oxalate lowest value was recorded in LC-15 (0.12 %) followed by LC-18 (0.13 %), LC-2 (0.14 %) and LC-5 (0.18 %) were statistically superior to standard check Muktakeshi (0.20 %) which is desirable in Colocasia. Starch content was found significantly higher in LC-1, LC-19, LC-10, LC-5, LC-7, LC-4 and LC-23 as compared to Muktakeshi (SC) with the highest sugar content being recorded in LC-1 (14.75 %) followed by LC-7 (14.71 %), LC-19 (14.67 %), LC-12 (14.41 %), LC-10 (14.38 %), LC-3 (14.26 %), LC-4 (14.25 %) and LC-17 (13.89 %) were statistically superior to standard check Muktakeshi (13.40 %). These results were reported by earlier researchers *i.e.*, Singh *et al*. (1993), Aggarwal (1999), Safa-Deleh and Aguir-Sackey (2004), Sudershan (2006), Tattiyakul *et al*. (2006), Chadha *et al*. (2007), James *et al*. (2013), Singh *et al*. (2003), Sood *et al*. (2011) and Termesgen and Retta (2015).

The promising genotypes under present investigation (Table 4), identified based on mean performance for yield and quality attributes; LC-10 (collection from Baijnath of district Kangra, HP) was found best for highest total yield, cormel yield, cormel diameter, corm yield, number of cormels/plant, sugar and starch content (7 characters) followed by LC-15 (collection from Kolar of district Sirmour, HP)for total yield, cormel yield, cormel diameter, corm yield, crude protein and lowest oxalate content (6); LC-8 (collection form Gagret, Tehsil Amb of district Una, HP)recorded highest total yield, cormel yield, number of cormels /plant and total polyphenols (4); LC-14 (collection from Sarkaghat of district Mandi, HP) for total yield, cormel yield andnumber of cormels /plant (3), LC-9 (collection from Village Bassi of district Mandi) for total yield, cormel yield and total polyphenols (3). Based on the performance of these genotypes, they can be utilized as source of germplasm in colocasia improvement program under natural farming conditions.

Table 4. Promising genotypes identified based on mean performance for yield and Quality attributes

Genotypes (Collected from)	Number of traits superior for	Traits
LC-10 (Baijnath, District Kangra)	7	Total yield, cormel yield, cormel diameter & corm yield, number of cormels/plant, sugar and starch content
LC-15 (Kolar, District Sirmour)	6	Total yield, cormel yield, cormel diameter & corm yield, crude protein and lowest oxalate content
LC-8 (VPO Ghanari, Block Gagret, Tehsil Amb, District Una)	4	Total yield, cormel yield, number of cormels/plant and total polyphenols
LC-14 (Sarkaghat, District Mandi)	3	Total yield, cormel yield and number of cormels /plant
LC-9 (Village Bassi, District Mandi)	3	Total yield, cormel yield and total polyphenols

Conflict of interest: The authors declare no conflict of interest in this research paper.

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