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Quality Evaluation of Indigenous Taro (*Colocasia esculenta* L.) Cultivars of Nagaland

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ABSTRACT

Twenty locally grown taro (*Colocasia esculenta* L. Schott.) cultivars were collected from different parts of Nagaland, and their morphological and chemical analysis were done. The different parameters analyzed include corm length, corm diameter, specific gravity, number of cormels, starch, calcium oxalate, moisture, dry matter, energy, nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg) and sulphur (S) contents. Wide variability in nutritional and other quality parameters like starch, calcium oxalate, dry matter etc. among the different taro cultivars was recorded. There was strong positive correlation ($P < 0.05$) between corm length and specific gravity; calcium oxalate and moisture content. Among the 20 cultivars, Nalon, Toongphak, Tanchong Shg, Angphak and Toa Boi were found superior to others with respect to yield attributes, nutritional and other quality parameters based on an over-all rank sum index (ORSI).

Keywords: Taro, quality parameters, nutritional assessment, Nagaland

INTRODUCTION

'Taro' (*Colocasia esculenta* L. Schlott.), a wetland herbaceous plant, is widely grown in the low and mid-altitude areas of Eastern Himalayan region. Wide variability exists in the taro genotypes grown in the North Eastern Hill region (Sarma 2001). It is also believed that the origin of domesticated taro is from 'wild type' *C. esculenta var. aquatilis*, either in North East India or South East Asia (Matthews 1991). Taro corms contain very high amount of starch and are a good source of dietary fiber and the leaves are rich in vitamins and minerals. Presently, taro is one of the prominent components of food items in Eastern Himalayan region, largely consumed by the rural population as a substitute to vegetables and it has other multi-purpose uses as well. The corms are consumed as cooked vegetables or are made into puddings, breads or poi. The large nutrient rich leaves are commonly eaten stewed. Petioles are fed to pigs after boiling with broken rice or rice bran.

In developing regions like North East India, food shortage and subsequent malnutrition particularly among the resource poor rural population is conspicuous. Besides rice, cultivation of such locally grown, nutritionally rich root crops like taro at large scale will increase the total food production and income of the farmers. However, before popularizing taro cultivation, identification of suitable locally adapted superior cultivars/ genotypes particularly with respect to its nutritional value is the foremost need. Unfortunately, very little or no attempt has been made in assessing nutritional quality and identification of suitable cultivar with respect to balanced diet in North East India. Therefore, in the present study, an attempt has been made to evaluate nutritional and other quality parameters of some of the most commonly grown taro cultivars across Nagaland.

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MATERIALS AND METHODS

Corrms of twenty different cultivars, namely, Nacon, Baikhi, Puptung, Angphak, Nalon, Tongngah, Bano, Laihi, Toongphak, Hoaktoa (Big), Hoaktoa (Small), Tanchong Shg, Toa Bih, Toa Boi, Tea Gumgumkhi, Tapniam Toalo, Toakhi Khilo, Mekshang, Toagam and Penjong Toalo, were collected from different parts of Nagaland. The taro cultivars were analyzed for their morphological, chemical and nutritional parameters following standard procedures. The morphological parameters like corm length (mm), corm diameter (mm), specific gravity and number of cormels were recorded following standard procedures. The moisture and dry matter contents were determined by drying 10g sample at 60°C untill constant weight of the sample was obtained (Rangana 1997). Starch content was determined by the method of Rangana (1997). Calcium oxalate content was determined by titration against standard $KMnO_4$ solution (AOAC 1984).

Percentage of total nitrogen (N) was determined by modified 'micro-Kjeldhal Method' (Subbiah and Asija 1956). A known quantity of powdered sample was digested and distilled and NH_3 released was passed into boric acid, which was then back titrated with standard acid. Determination of total phosphorous (P) was done by the Vanadomolydophosphoric yellow colour method (Bray and Kurtz 1945) and expressed in percentage. The estimation of total potassium (K) in the samples was carried out by Neutral Normal Ammonium Acetate method with the help of Flame Photometer (Jackson 1973) and expressed in percentage. Total calcium (Ca) and magnesium (Mg) were determined by Complexometric titration method in the samples after digestion with di–acid (Nitro–perchloric) mixture (Baruah and Barthakur 1997). For determination of total sulphur (S), the di-acid digested samples were subjected to turbidimetric estimation (Chesnin and Yien 1951). Energy estimation was done using 'Bomb Calorimetric System'.

Over-all rank sum index (ORSI) of the different cultivars of Colocasia was assessed on the basis of important morphological and nutritive characters. For each attribute, the rating was made using 0.25–1.0 scale (0.25 = poor, 0.50 = fair, 0.75 = good and 1.0 = excellent). Based on these estimates, the total score was then divided by number of accessions evaluated to present the pooled value of ORSI (Simonne et al. 1999).

The data obtained was statistically analyzed using critical difference at 5% level of probability (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Morphological parameters reflected wide variation among the cultivars (Table 1). Highest corm length of 169.2 mm was recorded in the cultivar Nalon while lowest (55.44 mm) was recorded in Toa Boi, with an average corm length of 103.3 mm ± 37.9 (number of cultivars, n=20). Similarly, corm diameter also depicted a significant variation from 152.1 mm (in cultivar Tanchong Shg) to 25.29 mm (in Tapniam Toalo) with an average diameter of 78.2 mm ± 39.1. As regards to specific gravity, the cultivars Toakhi Khilo and Penjeng Toalo recorded the highest value of 1.58 and the cultivar Hoaktoa (Small) recorded the least specific gravity of 1.08. A maximum of nine numbers of cormels were recorded in cultivar Toa Boi while Tapniam Toalo cultivar had no cormel. The reported values were within the range reported by Kay (1987).

Physical and yield attributing characters of cultivar, in fact, significantly influenced the productivity of Taro. From the results, it appeared that out of twenty cultivars, four namely Angphak, Nalon, Toongphak and Tanchong Shg were superior to others if cumulative values of size (length, diameter), specific gravity and number of cormels were accounted for (Table 1). Therefore, if higher productivity per unit land area is desired, then, these four cultivars could be suggested for cultivation by the farmers of Mon district from where they were collected. There was significant ($P < 0.05$) positive correlation between corm length and specific gravity. Though the corm length was weakly correlated with the corm diameter, yet, with an increase in length, diameter also increased marginally.

The quality parameters of the samples showed significant ($P < 0.05$) variations among the different cultivars (Table 2). The cultivars Puptung, Tongngah and Toagam had highest starch content (22.50%) while cultivar Penjeng Toalo recorded the lowest starch content of 10.84%. The highest moisture content of 80.56% was found in the cultivar Puptung, followed by Toagam (77.19%).

Table 1: Morphological parameters of some Colocasia cultivars of Nagaland

Name	Corm Length (mm)	Corm diameter (mm)	Specific gravity	Number of cormels
Nacon	76.61	59.84	1.30	3.00
Baikhi	72.30	79.63	1.11	4.50
Puptung	84.08	68.17	1.16	2.00
Angphak	116.47	146.03	1.16	2.00
Nalon	169.20	92.50	1.53	8.00
Tongngah	141.36	65.52	1.39	3.00
Bano	90.93	94.09	1.48	6.00
Laihi	85.49	33.05	1.37	1.67
Toongphak	123.00	144.39	1.38	5.00
Hoaktoa (Big)	57.20	110.00	1.25	2.50
Hoaktoa (Small)	64.62	45.16	1.08	1.00
Tanchong Shg	162.15	152.10	1.16	4.00
Toa Bih	69.14	118.51	1.39	6.00
Toa Boi	55.44	56.70	1.24	9.00
Tea Gumgumkhi	73.17	33.10	1.14	2.00
Tapniam Toalo	164.55	25.29	1.49	0.00
Toakhi khilo	127.23	44.83	1.58	2.00
Mekshang	70.42	71.14	1.21	3.00
Toagam	136.25	82.76	1.20	5.00
Penjeng Toalo	126.85	41.28	1.58	2.00
SeM ±	8.28	8.53	0.04	0.51
CD (*P*= 0.05)	23.57	24.30	0.12	1.45

The lowest value for moisture content was recorded in Hoaktoa (Small), i.e. 63.09%. The cultivar Hoaktoa (Small) exhibited the highest amount of dry matter content (36.91%) whereas, the cultivar Puptung recorded the lowest (19.91%). Wills et al. (1983) reported varietal variation in starch content and dry matter content in taro.

It was evident from the data (Table 2) that most of the cultivars recorded lower calcium oxalate values which ranged from 0.23 to 1.78 mg/100g. Among the cultivars, Toakhi Khilo had lowest content (0.23 mg/100g) while cultivar Puptung recorded the highest value of calcium oxalate, i.e. 1.78 mg/100g. Levels of oxalates are of interest because of their alleged adverse effect on nutrient bioavailability (Libert and Franceschi 1987). However, oxalates levels may not pose a health hazard since these are leached out during cooking. Huang et al. (2007) also reported the variation in calcium oxalate levels among different cultivars of taro. It was also found that calcium oxalate content and moisture content were significantly ($P < 0.05$) and positively correlated ($r = 0.60^*$). Dry matter content, however, showed significant ($P < 0.05$) negative correlation with calcium oxalate ($r = -0.60^*$) and moisture content ($r = -0.99^*$). Data pertaining to energy values ranged from 15.67 (in Toagam) to 16.92 MJ/kg in Hoaktoa (Small). Energy values were another important parameter, which gave more calories to the human beings, and the results of the present study were in close conformity with the findings of Wills et al. (1983) and Huang et al. (2007).

Table 2: Quality parameters of some Colocasia cultivars of Nagaland

Name	Starch (%)	Ca-oxalate (mg/100g)	Moisture (%)	Dry Matter (%)	Energy (MJ/Kg)
Nacon	17.03	0.72	65.17	34.83	16.15
Baikhi	15.93	0.45	72.24	28.43	16.11
Puptung	22.50	1.78	80.56	19.91	15.98
Angphak	21.37	0.28	65.61	34.39	16.75
Nalon	20.50	0.25	64.40	35.60	16.80
Tongngah	22.50	0.43	68.88	31.12	16.13
Bano	15.00	0.52	72.86	27.14	15.75
Laihi	12.50	0.54	65.01	34.99	15.75
Toongphak	19.60	0.30	68.82	31.18	16.75
Hoaktoa (Big)	12.68	0.47	64.54	35.46	16.10
Hoaktoa (Small)	19.15	0.25	63.09	36.91	16.92
Tanchong Shg	20.00	0.31	65.40	34.60	16.50
Toa Bih	13.43	0.40	64.75	35.25	16.29
Toa Boi	15.00	0.34	68.52	31.49	15.75
Tea Gumgumkhi	20.00	0.25	64.22	35.78	16.39
Tapniam Toalo	18.07	0.29	72.56	27.44	15.89
Toakhi khilo	20.45	0.23	63.81	36.19	15.99
Mekshang	16.67	0.31	68.98	31.02	16.09
Toagam	22.50	0.43	77.19	22.81	15.67
Penjeng Toalo	10.84	0.32	70.90	29.14	15.96
SeM ±	0.79	0.07	1.04	1.02	0.08
CD (*P*= 0.05)	1.66	0.15	2.18	2.14	0.17

The variation in quality parameters among the cultivars could be attributed to the varietal differences mainly governed by the genetic make-up of the particular cultivar. These differences might also be influenced by soil and environmental factors, which play crucial role in metabolic synthesis, translocation and storage of primary and secondary metabolites.

Among the nutrients analyzed, N content was found to be highest (1.79%) in Hoaktoa (Small), followed by Tanchong Shg (1.75%). The cultivar Hoaktoa (Big) had the lowest N content of 0.63%. The data for P content also showed significant ($P < 0.05$) variation among the cultivars: ranging from 1.30 % (Nalon) to as low as 0.10 % (in cultivars Hoaktoa (small), Toa Boi, Mekshang & Toagam). K content also varied significantly ($P < 0.05$) which was found to be the highest (3.80%) in Toongphak and the lowest in Mekshang (0.20%). The values for total Ca ranged from 42.0 (Puptung) to 120.0 (Tea Gumgumkhi) meq/100g of dry matter. The indigenous taro cultivars evaluated for this study had sufficient amount of Ca, particularly in the cultivars like Angphak, Nalon, Bano, Toongphak, Tanchung Shg, and Toa Boi. In an earlier study, Englberger et al. (2008) also reported that variation in Ca content was observed in Micronesian giant swamp taro (Crytosperma) cultivars. Similarly, total Mg content varied widely. Nalon recorded the highest value of 212.0 meq/100g dry matter followed by Tanchong Shg (160.0 meq/100g dry matter). The cultivar Hoaktoa (Big) had the lowest amount of total Mg content (6.0 meq/100g dry matter). Cultivar Tea Gumgumkhi recorded the highest value of total S (3064.30 mg/kg) whereas Toakhi Khilo had the lowest value (135.70 mg/kg). The correlation studies showed that N and P contents were significantly ($P < 0.05$) and positively correlated with most of the nutrient elements. An increase in any of the nutrients would bring an increase in all other nutrient contents (Table 3).

The wide variations in chemical composition of different colocasia cultivars might be primarily due to varietal differences, which ultimately determined the nutritional values of a particular crop since all the cultivars were grown under similar climate and soil type with uniform cultivation practices (Barooah 1982). Similar observations were also made by Wills et al. (1983) for taro cultivars grown in Papua New Guinea highlands.

Over-all rank sum index (ORSI) was calculated taking into account the most important characters like cormel number, starch , calcium oxalate, dry matter, total Ca, total Mg and total S contents in

Table 3: Nutritional composition of the colocasia cultivars of Nagaland

Name	N (%)	P (%)	K (%)	Total Ca (meq/100g dry matter)	Total Mg (meq/100g dry matter)	Total S (mg/kg)	ORSI
Nacon	1.27	0.23	0.80	54.00	46.00	1964.3	0.27
Baikhi	0.97	0.13	0.69	94.00	42.00	1100.0	0.33
Puptung	1.12	0.30	0.30	42.00	28.00	1857.1	0.24
Angphak	1.72	1.28	2.99	110.00	150.00	2850.0	0.41
Nalon	1.64	1.30	1.78	115.00	212.00	2328.6	0.52
Tongngah	0.91	0.30	0.49	50.00	72.00	821.4	0.31
Bano	1.12	0.20	0.38	100.00	110.00	1242.9	0.40
Laihi	1.30	0.30	3.55	80.00	46.00	1914.3	0.31
Toongphak	1.70	0.98	3.80	100.00	110.00	2021.4	0.44
Hoaktoa (Big)	0.63	0.23	0.52	74.00	6.00	1442.9	0.27
Hoaktoa (Small)	1.79	0.10	0.25	96.00	42.00	2085.7	0.34
Tanchong Shg	1.75	1.25	2.80	100.00	160.00	2335.7	0.44
Toa Bih	1.47	0.30	3.60	46.00	110.00	1964.3	0.39
Toa Boi	1.23	0.10	0.62	115.00	12.00	1550.0	0.40
Tea Gumgumkhi	0.91	1.23	0.83	120.00	16.00	3064.3	0.34
Tapniam Toalo	0.76	0.20	0.80	58.00	34.00	1911.6	0.27
Toakhi khilo	0.92	0.20	0.80	72.00	44.00	135.7	0.29
Mekshang	0.90	0.10	0.20	72.00	68.00	1257.1	0.32
Toagam	0.70	0.10	0.56	84.00	20.00	1635.7	0.35
Penjeng Toalo	1.12	0.20	0.31	98.00	62.00	2571.4	0.33
SeM ±	0.08	0.10	0.28	5.35	12.14	151.03	—
CD (*P*= 0.05)	0.17	0.21	0.59	11.24	25.49	317.16	

different cultivars of Colocasia. Based on ORSI, cultivar Nalon was found to be the best, followed by Toongphak, Tanchong Shg, Angphak, Bano and Toa Boi. Hence, these cultivars could be suggested for cultivation in large scale.

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