Morphological Characterization Of Some Nalkachu Genotypes

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ABSTRACT
Comparative morphological study of thirteen varieties of Colocasia esculenta (L.) Schott present in Assam, Manipur and west bengal State, India was carried out, in order to furnish plant taxonomists with information which could be of great help in delimitation of the varieties. The result showed that adaxial surface of Manipur green, Manipur black, BCKVST-1, BCKVST-3, BCKVST-5, BCKVST-13, BCKVST-14, Tezpur and Karimganj pink had a purplish dot on the centre, abaxial leaf surface of BCKVST-1, BCKVST-3, BCKVST-5, BCKVST-13, Tezpur and Bilahipara black had a conspicuous purplish colour at the point of attachment to the leaf, and the caudex had numerous striking vertical purple stripes on the surface. The leaf lamina ranged from 1.70±1.78cm (Bholakachu) to 1.51±1.83cm (BCKVST-3). Petiole length of Bholakachu was the highest (92.15±29.50cm), whereas the least was Manipur green (61.87±19.70cm). The caudex length ranged from 77.21cm (Bholakachu) to 21.82cm (BCKVST-14), while the stolon length ranged from 127.13cm (BCKVST-14) to 62.17 cm (Karimganj). This work has revealed diagnostic and differential morphological characters, which could be useful for identification and description of varieties of C. esculenta. In addition, it provided additional information which might be helpful in resolving the ongoing controversy in the taxonomy of Colocasia, which would, in turn, probably lead to possible delimitation of C. esculenta.

Keywords: Colocasia, Caudex, Diagnostic characters, Morphological characters, Plant taxonomy

INTRODUCTION
Nalkachu (Colocasia esculenta var. stolonifera) is one of the important tuber crops of Assam. Unlike other upland colocasia cultivars, nalkachu is grown for stolon as well as caudex. It is also cultivated in West Bengal and Bangladesh. It is a highly nutritious tuber crop, which contains good amount of starch, calcium, iron, β-carotene, vitamin B1 and vitamin-C. It can be cultivated with minimum effort and it can sustain growth in water logged environment, tolerate brief submergence (Roy Chowdhury et al., 2010). So this crop is easily cultivated in low lying areas where other vegetable crops cannot be grown. The crop is also highly remunerative and a commercial crop can give an income of about Rs. 52,000 per ha (Saud and Barua, 2000). The crop produces runner (stolon) which is preferred as a vegetable and is very popular in Assam, Bihar, West Bengal and adjoining Bangladesh. In some cultivars, after harvesting of stolons, the caudex fully develop and are the main marketable part of the crop. Depending upon cultivars, stolons, leaves, petioles and caudex are used as vegetable (Roy Chowdhury et al., 2004). In comparison to other crops, it has better light utilization strategies even under low light conditions prevalent during cloudy monsoon (Roy Chowdhury et al., 2008; 2009). The observed varieties of C. esculenta showed a lot of variability in morphological characters. This variability is common among crops that have been cultivated for a long time. The knowledge of variability of C. esculentas deficient and limited. In addition, there is paucity of literature on its taxonomy, which implies that thorough taxonomic research has not been done on C. esculenta (Ezeabaraet al., 2015). As a result, a morphological study on varieties of C. esculenta becomes a necessity; because morphological characters are the strongest tools used in taxonomic classification of plants, and this makes its application very crucial (Ezeabaraet al., 2015). Plants are generally grouped by their relationship to one another based on their similarities and differences, which is based on the characters they possess. This study, therefore, supplied additional morphological
information which might be helpful in resolving the on going controversy in the taxonomy of *Colocasia*, which would in turn, probably lead to possible delimitation of *C. esculenta* (Ezeabara et al., 2015).

**MATERIALS AND METHODS:**

**Sources of materials**
The materials for the present investigation comprised of 13 cultivars 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 2.1

**Table 2.1. List of genotypes with its place of collection**

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manipur black, Manipur green</td>
<td>Manipur</td>
</tr>
<tr>
<td>BCKVST-1, BCKVST-3, BCKVST-5, BCKVST-13, BCKVST-14</td>
<td>West Bengal</td>
</tr>
<tr>
<td>Tezpur, Bholakachu, Hybrid, Karimganj, Karimganj pink, Bilachipara black</td>
<td>Assam</td>
</tr>
</tbody>
</table>

**Morphological study**
The petiole and leaf measurements were done in February 2014; hence the plants were four months old when the measurements were done. The caudex and stolons were measured in August 2015. The meristem of the caudex were removed untill they cannot be removed without force; Stolons from the base of the main stem were randomly chosen and third fully opened active leaves and petioles from the base were measured. The petiole measurement started from the ligule to the base of the leaf. The raw caudex and stolons from the base of the main stem were peeled with knife. Observations and measurements of the plants parts were done using eye lens thread and ruler. Photographs of the habit and plant parts were taken with digital camera (Sony Dsc-W230, China).

**Statistical analysis:**
The data were subjected to the analysis of variance for Randomized Block Design as suggested by Panse and Sukhatme (1985). Partitioning the total variance into replications and treatments represented the expectations of the variance and the appropriate degrees of freedom in each case. The computation of analysis of variance is as follows:

The model of ANOVA used is presented below:

\[ Y_{ij} = \mu + g_i + v_{ij} + e_{ij} \]

**RESULTS:**
The leaf of all the varieties was thick, succulent and downward-pointing, with reticulate venation. Three strong midribs arose from the point of attachment to the petiole, the main midrib pointed towards the basal lobe, while other two smaller midribs extended to the two posterior lobes, with one midrib on each lobe. The primary lateral veins originated from the three midribs, while the veinlets emanated from these primary lateral veins. The leaf margin was entire and undulate; the leaf blade was sagittate and peltate but not shiny, the abaxial and adaxial surfaces of the leaf blade were glabrous; the anterior lobes were twice as large as the posterior lobes, which were round in shape; and the petiole attachment was peltate. Petiole had a wide range of colors, including pale green, dark green, yellowish green and purple (Figure 1(a)). The base of petiole of BCKVST-5 was deep purple (Figure 1(b)). When compared with other varieties (Figure 1(c)), the leaf of Karimganj has a prominent distinctive feature, which was presence of a purplish dot on the centre of the adaxial surface (Figure 1(d)). The petiole of Manipur green was yellowish green (Figure 1(e)) and Table 1). While that of Bholakachu was purple in colour. While other varieties like Karimganj absent in petiole junction colour (Figure 1(f)). Abaxial leaf surface of Bilachipara black had a conspicuous purplish colour at the point of attachment to the leaf (Figure 1(g)).

*Colocasia esculenta var. stolonifera* and Bholakachu had large caudex which were more or less cylindrical in shape. (Figure 1(h)) Where as caudex of BCKVST-14 and BCKVST-1 were more or less oval. (Figure 1(i)) stolons of BCKVST-14 and BCKVST-13 were long (Figure 1(j)). They were relatively longest, where as those of Bholakachu were the smallest. (Figure 1(k)).

There was significant difference among the petiole length of all the varieties at p<0.05. Petiole length of Bholakachu was the highest (92.15±29.50cm), whereas the least was Manipur green (61.87±19.70cm), where as others differed. There was significant difference among the leaf lamina of all the varieties at p<0.05. The leaf lamina ranged from 1.70±1.78cm (Bholakachu) to 1.51±1.83cm (BCKVST-3). The leaves of Bholakachu were deep green colour, while those of Hybrid were light green. There was significant difference among the caudex length of all the varieties The caudex length ranged from 77.21cm (Bholakachu) to 21.82cm (BCKVST-14). There was significant difference among the stolon length of all the varieties. While the stolon length ranged from 127.13cm (BCKVST-14) to 62.17 cm (Karimganj).
Figure 1 Photos Showing habit, abaxial leaf surface, length of caudex and length of stolon of nalkachu varieties

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Petiole Length</th>
<th>Petiole Colour</th>
<th>Leaf Lamina</th>
<th>Leaf Colour</th>
<th>Caudex Length</th>
<th>Length of Stolon (cm)</th>
<th>Girth of Stolon (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAUST-3</td>
<td>25.44±72.31</td>
<td>Purple</td>
<td>1.9±1.64</td>
<td>Dark green</td>
<td>44.36</td>
<td>74.9</td>
<td>0.63</td>
</tr>
<tr>
<td>BCKVST-5</td>
<td>22.7±65.88</td>
<td>Green</td>
<td>2±1.54</td>
<td>Light green</td>
<td>31.38</td>
<td>101.57</td>
<td>0.63</td>
</tr>
<tr>
<td>AAUST-5</td>
<td>21.39±66.31</td>
<td>Green</td>
<td>1.7±1.63</td>
<td>Dark green</td>
<td>35.22</td>
<td>76.13</td>
<td>0.65</td>
</tr>
<tr>
<td>AAUST-4</td>
<td>18.8±65.08</td>
<td>Green</td>
<td>1.53±1.68</td>
<td>Dark green</td>
<td>33.23</td>
<td>62.17</td>
<td>0.49</td>
</tr>
<tr>
<td>CAUST-2</td>
<td>19.7±61.87</td>
<td>Green</td>
<td>1.45±1.71</td>
<td>Dark green</td>
<td>32.21</td>
<td>63.9</td>
<td>0.54</td>
</tr>
<tr>
<td>BCKVST-3</td>
<td>23.23±69.02</td>
<td>Purple</td>
<td>1.83±1.65</td>
<td>Dark green</td>
<td>31.7</td>
<td>105.93</td>
<td>0.79</td>
</tr>
<tr>
<td>AAUST-1</td>
<td>28.13±86.83</td>
<td>Green</td>
<td>1.19±1.66</td>
<td>Light green</td>
<td>64.45</td>
<td>100.47</td>
<td>0.73</td>
</tr>
<tr>
<td>BCKVST-14</td>
<td>28.4±81.98</td>
<td>Green</td>
<td>1.99±1.66</td>
<td>Dark green</td>
<td>21.82</td>
<td>127.13</td>
<td>0.87</td>
</tr>
<tr>
<td>AAUST-2</td>
<td>29.5±92.15</td>
<td>Green</td>
<td>1.78±1.7</td>
<td>Light green</td>
<td>77.21</td>
<td>116.67</td>
<td>0.83</td>
</tr>
<tr>
<td>AAUST-6</td>
<td>27.23±78</td>
<td>Green</td>
<td>1.62±1.72</td>
<td>Light green</td>
<td>49.54</td>
<td>88.53</td>
<td>0.63</td>
</tr>
<tr>
<td>BCKVST-13</td>
<td>26.2±77.21</td>
<td>Green</td>
<td>1.97±1.69</td>
<td>Dark green</td>
<td>33.82</td>
<td>121.03</td>
<td>0.75</td>
</tr>
<tr>
<td>CAUST-1</td>
<td>21.13±71.78</td>
<td>Green</td>
<td>1.87±1.71</td>
<td>Dark green</td>
<td>31.03</td>
<td>67.33</td>
<td>0.63</td>
</tr>
<tr>
<td>BCKVST-1</td>
<td>21.36±62.4</td>
<td>Green</td>
<td>1.97±1.62</td>
<td>Dark green</td>
<td>32.44</td>
<td>91.93</td>
<td>0.63</td>
</tr>
</tbody>
</table>

AAUST-1= Tezpur, AAUST-2= Bholakachu, AAUST-3= Hybrid, AAUST-4= Karimganj, AAUST-5= Karimganj pink, AAUST-6= Bilachipara black, CAUST-1= Manipur black, CAUST-2= Manipur green.

DISCUSSION

The common leaf features of all the varieties of colocasia same. The appearance of *C. esculenta* and *X. sagittifolium* are sometimes confusing, as a result of their similarity. The leaves of *Xanthosoma* (Tannia) are large, approximately 20cm in length, 15cm in width, hastate (sagittate-ovate) in shape, with the anterior lobe twice as large as the posterior lobe, with distinct marginal vein, and round basal lobes. In addition, the petiole attachment of *Xanthosoma* is at the margin of the leaf. Leaves of *X. sagittifolium* nearly in rosette in acaulescent plants, or in a distal crown in mature plants. Blades horizontal to slight ascending, with the posterior lobes ascending, simple, upper surface dark green with light green primary secondary veins on basal lobes, lower surface light green with dark green veination; petioles light green;
basal lobes of the leaf sub rhomboid obtuse; colocasia can therefore, easily distinguished from *Xanthosoma* by the point where the petiole is attached to the leaf. In colocasia, the petiole attachment was peltate, where as for *Xanthosoma*, the petiole attachment is at the margin of the leaf. Moreover, *C.esculenta* can be differentiated from *X. sagittifolium* by shape of the basal lobes, position of the leaf blades, and colour of petiole and leaf. In *Colocasiaesculenta* the basal lobe of leaf was round, leaf blade pointed downward, and leaf colour was dark green with petiole colour ranging from pale green, dark green, yellowish green and purple; while for *X.sagittifolium*, basal lobes is sub-rhomboid obtuse, blades horizontal to slight ascending, with leaf and petiole light green. It has been stated that morphological characteristics are the strongest determinants of the agronomic value and taxonomic classification of plants.

Generally, all the varieties of *C.esculenta* looked alike in the field until a closer look was made. Interestingly, however, there were remarkable differences in some parts of the varieties. The variety of Bholakachu was the highest leaf lamina; and deep purple colour of the petiole was the most conspicuous morphological feature differentiating it from others. Diagnostic character for Bholakachu was location of purplish spot in the centre of the adaxial surface of the leaves. The use of leaf characters in classification and identification of plants has been extensively reported. It has been documented that the leaf characters such as arrangement, type, form, duration and veination are widely used in both classification and identification in palms, *Salix* and *Populus*. Leaf character has been reported to be critical tool in the hand of taxonomists in the classification and separation of taxa.

Moreover, there were some similarities between *C.esculenta var. stolonifera* and *C. esculenta var. esculenta*. There was a significant difference in the leaf lamina of all the genotypes. The leaf lamina ranged from 1.70±1.78cm (Bholakachu) to 1.51±1.83cm (BCKVST-3). However some morphological characters can be used in differentiating them. There was significant difference among the caudex length of all the varieties. The caudex length ranged from 77.21cm (Bholakachu) to 21.82cm (BCKVST-14). There was significant difference among the stolon length of all the varieties. While the stolon length ranged from 127.13cm (BCKVST-14) to 62.17 cm (Karimganj). Bholakachuhad large caudex length and BCKVST-14 had small caudex length. Incase of stolon length BCKVST-14 had large stolon length and Bholokachu had small stolon length, therefore, were the most prominent morphological characters which distinguished them from each other. Some other characters have extensively been used to differentiate between *Cesculenta var stolonifera* and *C.esculenta var esculenta* by various workers.

There was also significant difference in the caudex length, caudex width and stolon length of all the varieties of *C.esculenta*. This indicated that these characters could be useful in distinguishing the varieties. Long caudex length of “Bholakachu” could be used as a ready distinctive character, as well as the largest stolon length and stolon width of BCKVST-14. It has been specified that under ground parts, such as roots and tubers, are of some taxonomic value in plants. The tubers are helpful in the taxonomy of *Dioscorea* and *Cyperaceae*. Such a vegetative characters that play a major role in plant taxonomy and deducing phylogeny include growth habit, phonological characters, underground organs, stems, leaves, petiole and stipules. Three sesame species, namely *Sesamumalatum*, *S. radiatum* and *S. indicum* were differentiated on the basis of their vegetative and the pod characteristics. In addition, such characteristics, because of their high taxonomic importance, could be used in constructing a taxonomic key for the purpose of easy and quick identification of the three sesame species irrespective of their growth environment.

**CONCLUSION:**

This work provided information on the morphology of these thirteen varieties of *Colocasiaesculenta var stolonifera* present in Assam, Manipur and West Bengal state India; Which was previously lacking, secondly, the overwhelming evidence from this study suggested close relatedness between *C.esculenta var stolonifera* and *C. esculenta var esculenta* provided diagnostic characters for “Bholakachu”, “BCKVST-14” and “Manipur green.”

Conspicuous diagnostic characters observed in “Bholakachu” were presence purplish colour at point of attachment to the leaf of the abaxial surface, as well as presence of purplish dot on the center of the adaxial surface of the leaf, and numerous purplish stripes on the surface of the caudex. Purplish colour of petiole and yellowish green colour of “Bholakachu” and “Hybrid” was only the diagnostic character. The differential character include, large caudex length with cylindrical shapein “Bholakachu” and small caudex length with oval shape in “BCKVST-14”.

Plants are generally grouped by their relationship to one another based on their similarities and differences, which is based on the characters they possess. This study, therefore, supplied additional morphological information which might be helpful in resolving the on-going controversy in the taxonomy of colocasia, which would, in turn, probably lead to possible delimitation of *C.esculenta*.
REFERENCES


**CITATION OF THIS ARTICLE**