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KARYOTYPE ANALYSIS OF SEVEN VARIETIES OF TARO *COLOCASIA ESCULENTA* (L.) SCHOTT. FROM BANGLADESH

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Abstract

Nuclear and chromosome characteristics of seven varieties of *Colocasia esculenta* were studied. Interphase chromosome value was found to range from 2119.85 (cytotype-3) to 5346.12 (cytotype-7). Heterochromatin values varied from 23.17 (cytotype-2) to 44.52% (cytotypt-6) in meristematic cells. Karyotype studies revealed that somatic chromosome number was 28 in cytotype-1, 2, 5, 6 and 7; 42 in cytotype-3 and 21 in cytotype-4. The longest chromosome (5.54 µm) was observed in cytotyopt-2 and shortest (1.3 µm) in cytotype-3 and 6.

Key words: Karyotype, Nuclear phenotype, *Colocasia esculenta.*

Introduction

The family Araceae is consisting of 1400-1500 species under 105 genera distributed largely in the tropics (Lawrance 1966). *Colocasia esculenta* (L.) Schott., one of the members of this family shows great diversity in morphological characters. In Bangladesh, there are many cultivated and wild varieties of *C. esculenta*. These have been classified on the basis of their morphological characters and locality. These forms are very much distinct, particularly in height and leaf characters. Barrau (1957) recognized two spp. namely *C. esculenta* and *C. antiquorum* Schott. But they are also recognized as two botanical varieties, var. *C. esculenta* and var. *C. antiquorum* (Hill 1939). The basic chromosome numbers of x=12 and x=14 for *C. esculenta* were reported by earlier (Rao 1947, Delay 1951, Darlington and Wylie 1955). On the other hand, Fukushima *et al*. (1962) reported 2n=28 or 2n=42 in 100 cultivars from Japan. Based on detailed karyological study, Marchant (1971), Krishnan and Magoon (1977) have reported the basic chromosome number of x=7 for this species. The present study was undertaken to study the local varieties of *C. esculenta* on the organization of their interphase nucleus, heterochromatin contents and similarities and difference amongst the karyotypes to each on of the diploid or polyploid to provide diagnostic features of different chromosome in their chromosome complement as well as to depict the ploidy level for polyploid species.

Materials and Methods

Seven perennial varieties of *C. esculenta* namely, Panikachu (C-1), Mankachu (C-2), Kalokachu (C-3), Ashukachu (C-4), Ghatmankachu or Moulvikachu (C-5), Goalpatakachu (C-6) and Bankachu (C-7) collected from different places of Bangladesh were used as research materials in this study. The different varieties were denoted as different cytotypes. For nuclear phenotype and karyotype analysis, the root tips of seven cytotypes were pretreated with a saturated solution of Para Dichloro Benzene (PDB) followed by fixation in 1:3 aceto-alcohol and preservation in 70% ethyl alcohol. Chromosome staining was done according to Haque *et al.* (1976). Photomicrographs were made from the metaphase plate and the chromosomes were measured from cameralucida drawings. Nuclear volume (NV) was calculated using the formula for a sphere

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V=4/3 μr^3 (Nayar *et al.* 1971). The nuclear volume divided by the somatic chromosome number gave the interphase chromosome volume (ICV).

Results and Discussion

Somatic chromosome number of these seven cytotypes varied from 21 to 42 (Table 1). Cytotypes- 1, 2, 5, 6 and 7 showed 2n=28 chromosomes while cytotype- 3 had 2n=42 chromosomes. 2n=3x=21 chromosomes were found in cytotype-4. This is a new cytotype report for this species. Cytotype having 2n=42 chromosomes showed exact multiplication of 2n=21 i,e a hexaploid distribution. But morphologically this type (2n=42) did not show any polyploid feature. The individual with 42 chromosomes might be considered as cytotype of *C. esculenta.* Metaphase plate of each cytotypes is shown in Figs. 1a to 7a.

The chromosomes were measured from cameralucida drawings (Figs. 1b-7b) of metaphase plate. Karyotype differences were observed regarding chromosome length, total chromatin length of the haploid complement type etc. Among the types studied, longest chromosome (5.54 μm) was observed in cytotype-2 and shortest (1.3 μm) in cytotypes-3 and 6 (Table 2). Total chromatin length (TCL) of seven cytotypes were found to be 44.30 μm (c-1), 57.10 μm (c-2), 48.00 μm (c-3), 21.30 μm (c-4), 41.30 μm (c-5), 23.30 μm (c-6) and 34.20 μm (c-7) (Table 2). According to Stebbins (1950), decrease in TCL is one of the factors indicating the trend for evolution. Thus cytotype-4 (3x=21) may be considered as most advanced and cytotype-2 as primitive among the cytotypes of *C. esculenta* studied. On the other hand, the species having asymetrical karyotype is supposed to be more advanced than symmetrical ones (Stebbins 1950). From this point of view cytotype-6 may be considered as primitive among the seven types of *C. esculenta* studied since it possessed all metacentric chromosomes (Table 2). In contrast, cytotype-2 possessed maximum heterogenous karyotype in respect of centromeric position and hence may be considered as advanced (Table 2). On the basis of TF%, cytotype-2 (43.28) may be considered to be the most advanced while cytotype-6 (54.64) as the most primitive one (Table 2).

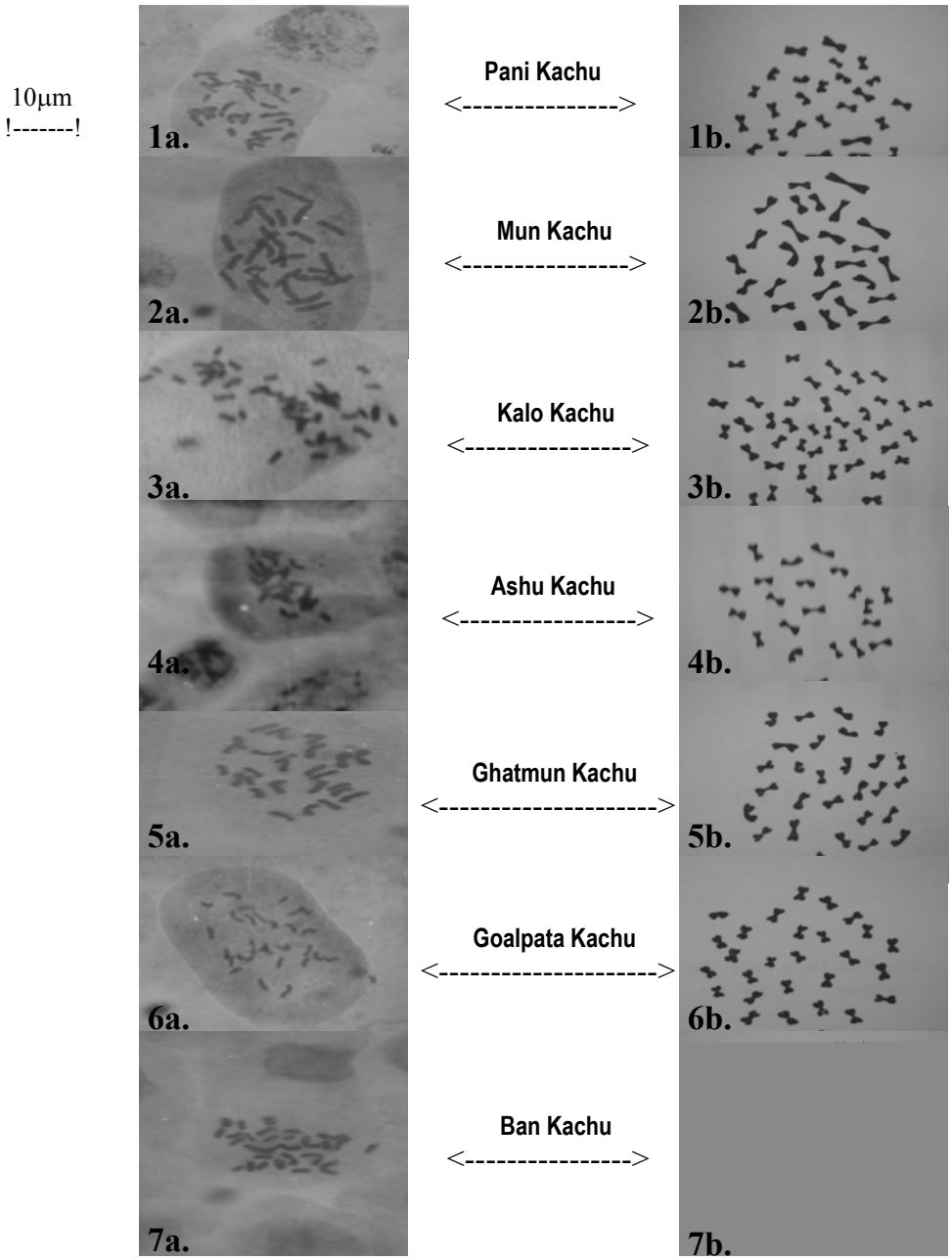
Table 1. Nuclear phenotype in seven cytotypes of *Colocasia esculenta.*

Cytotypes	Chromosome number	Mean No. of chromocentre ± SE	Heterochromatin % per nuclear area ± SE	Nuclear volume (μ^3)	Interphase chromosome volume ($\overline{X}$)± SE
C-1	28	20.25±0.32	24.43±0.38	103347.32	3922.41±310.75
C-2	28	23.92±0.30	23.17±0.55	116433.04	4158.33±286.73
C-3	42	39.36±0.34	31.46±1.05	82409.66	2119.85±122.71
C-4	3x=21	19.32±0.28	42.52±1.33	69561.13	3312.43±270.72
C-5	28	24.08±0.40	28.12*±0.54	81279.11	2902.83±154.94
C-6	28	22.36±0.30	44.52*±1.24	62151.24	2143.78±189.76
C-7	28	22.24±0.32	37.45**±1.20	142511.29	5346.12±382.24

NS = Non significant, * = Significant at 1% level, ** = Significant at 0.1% level

Table 2. Total chromatin length (TCL), Total frequency (TF%) and chromosome formula in seven cytotypes of *Colocasia esculenta.*

Cytotypes	Ploidy	Range of chromosome length (μm)	Total chromatin length (μm)	TF%	Chromosome formula (CF)			
					L	M	S_1	S_2
C-1	4x	1.96-4.88	44.30	43.57	L^m	$3M^m+2M^{sm}+M^{st}$	$3S^m+S_1+S_1^{st}$	$2S_2^m$
C-2	4x	2.60-5.54	57.09	43.28	$4L^m+L^{sm}+L^{st}$	$5M^m+M^{sm}+L^{st}$	S_1^m	-
C-3	6x	1.30-3.26	48.01	51.30	-	$2M^m+M^{sm}$	$9S_1^m+S_1^{sm}$	$8S_2$
C-4	3x	1.96-3.96	21.27	47.67	-	$4M^m$	S_1^{sm}	$2S_2^m$
C-5	4x	2.04-3.90	41.33	44.06	-	$5M^m+M^{sm}$	$5S^m+S_1^{sm}$	S_2^m
C-6	4x	1.30-2.60	23.26	54.64	-	-	$2S_1^m$	$12S_2^m$
C-7	4x	1.50-3.58	34.22	47.57	-	M^m+2M^{sm}	$5S_1^m+S_1^{sm}$	$5S_2^m$



Figs. 1-7 (a-b). Somatic metaphase chromosomes in seven cytotypes of *Colocasia esculenta* (Ca. 750x). **1a-7a.** Photomicrographs of somatic metaphase chromosomes in seven cytotypes of *C. esculenta* **1b-7b.** Camerlucida drawings of the somatic metaphase chromosomes in seven cytotypes of *C. esculenta*

2n=28 was reported in different forms of *C. esculenta* generally found in Bangladesh (Jackson *et al*. 1977) while the forms having 2n=42 are from Australia, New Zealand, Japan, Nepal and India (Mookerjea 1955). In the present analysis 2n=28 chromosomes form was found in five cytotypes (1, 2, 5, 6 and 7), 2n=42 in one cytotype (c-2) and 2n=21 in cytotype-4. The somatic chromosome complement as arranged confirms the hypothesis that this forms (3x=21) has a basic number of x=7. This led to assume that the ascestors might possess 2n=2x=14. From this point of view, the cytotypes with 2n=28 and 2n=42 chromosomes could be considered as tetraploid and hexaploid, respectively. On the other hand, cytotypes- 1, 2, 5, 6 and 7 (2n=28) may be considered as tetraploid. The ancestral (2n=2x=14) and tetraploid (2n=4x=28) species after hybridization might give rise to a triploid cytotype (2n=3x=21). This triploid cytotype by somatic doubling might give rise to the hexaploid one.

Interphase nuclei of meristematic cells of seven cytoptypes of *C. esculenta* were found to be chromocentric. Chromocentric nuclear organigation was reported in pulses, such as *Phaseolus* spp. (Patanker and Ranjekar 1984) and *Cicer* spp. (Kabir and Singh 1989). The chromocentres of *C. esculenta* become more clear and distinct after disruption of euchromatin indicating their heterochromatic nature. The number of chromocentres in the nuclei of meristematic cells ranged from 19.32 (c-4) to 39.36 (c-3) always less than their chromosome number 21 and 42, respectively.

Since chromocentres correspond to heterochromatin, the values of nuclear area and chromocentric area were used to determine the heterochromatin percentage. According to Lavania and Sharma (1983), there is a tendency to showed heterochromatic segments during the course of evolution. Thus, the older plants may have more heterochromatin than the recent one. Based on this concept cytotype-6 (44.52%) can be regarded as primitive and cytotype-2 (23.17%) as advanced one among seven cytotypes studied. In order to find out the statistical difference between the cytotypes having same chromosome number "t" test was used (Table 1). Cytotypes-5, 6 and 7 showed significant difference for this character with that of the cytotypes-1 and 2. However, the cytotypes-3 and 4 found to be contemporary to the cytotypes-6 and 7.

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