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Karyotype Analysis and Folding Rate of Chromosomes in Common Onion (*Allium cepa* L.)

Ahmet Okumuş¹ and Lutful Hassan²

¹Ondokuz Mayis University, Agriculture Faculty, Biometry-Genetics Department, Samsun, TR ²Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract: Onion chromosomes (*Allium cepa* L.; 2n = 2x = 16) were analyzed for karyotype analysis using aceto-orcein staining technique, and classified due to their lengths from long to short arms whether satellite exists or not. The length of arms appeared to be very close to each other and got more force their identification. The length of long arms showed a variation from 5 to 14 μ m while short arms have 2 to 10 μ m at the early and late stages of mitotic metaphase. The reason of this variation comes from the stages which observed as late prophase in mitosis. This different chromosome length also was affected in regard to the satellite position seen on long chromosome. The folding rate changed between 1.01 to 2.16 due to the smallest total length of chromosomes.

Keywords: Allium cepa, Karyotype analysis

Introduction

Karyotype analysis is important in the identification and designation of chromosomes in many plant and animal species. In plants, karyogram and idiogram of many species have been made such as avena (Thomas, 1968), barley (Singh and Tsuchiya, 1982), wheat (Sears, 1956) and rye (Sadanaga, 1957).

The genus *Allium* comprises over 600 species (Jones, 1990). *Allium* species exhibit different ploidy levels changing 2 x (*A. cepa, A. fistulosum, A. sphaerocephalon, A. ursinum*), 3 x (*A. amplectans, A. sphaerocephalon*), 4 x (*A. amplectans, A. montanum, A. vineale*), 5x (*A. oleraceum*) (Jenkins and Okumus, 1992). *A. cepa* is a diploid, contains 2n = 2x = 16 chromosomes (Stockert *et al.*, 1970) and consist of alien addition line relationship has been established cytogenetically from *A. fistulosum* (Peffley *et al.*, 1985).

A. cepa is produced as a plant having economic importance in the country, however, any comprehensive study on chromosome was not done yet. This study reports the basic study of chromosome karyotype on onion according to its chromosome morphology during early and late metaphase of mitosis.

Materials and Methods

Allium cepa L. is a biannual diploid plant known as common onion in Turkey. Onions obtained from the farmers were growth. Details about cultivar used are not available. The onions were grown in narrow-glass bottle for root development in room temperature. Mitotic material was obtained from meristematic root after 7 days of growth onion.

Meristematic-root cell nuclei were prepared for light microscopy by conventional squashing in aceto-orcein of root tissue after heating. They were photographed under Nikon Universal microscope equipped with an MC 100 camera. The chromosomes were measured under 400 magnification using a micrometer. The data were classified according to chromosome size, satellite present and the arm rates studied were calculated using nomenclature of chromosomes based on Levan *et al.* (1964). The folding rate was analysed according to the smallest total length of chromosomes among the cells using the stage differences due to the formula which is the total chromosome length of interested cell/the smallest total length. The index, also, was calculated with the rates of long and short arms of chromosomes.

Results and Discussion

On the mitotic analyzing of onion whose chromosome number was established as 2n = 16, total chromosome length had a deal

on changing between 8 and 26 μ m including satellite length. On the other hand, it was not observed any B chromosomes as *Allium*schoenoprasum (Holmes and Bougourd, 1982). Although the difficulty because of not straight of their chromosomes, only ten cells were utilized clearly because of their long chromosome length at mitosis. In addition, the chromosomes showed a variation on their length possibly appearing from the division period of mitosis. The chromosomes were classified according to their total length as early (up from 100 μ m) and late (down from 100 μ m) metaphase of mitosis. The classification implied that the chromosomes carrying satellite were longer than without satellite ones in early stages. The stage was more advance the length of chromosome got shorter changing with the karyotype of chromosome.

Early stage: Six cells were analysed in this stage in Table 1. In the cells studied, the longest chromosome was displayed to be $26 \,\mu$ m with the index 1.16 and the shortest chromosome had 8 μ m with the index 1.66. The shortest total chromosome length was displayed as 105 μ m while the longest length had 189 μ m per nucleus. The mean total length of chromosomes were calculated as 132.16 μ m, whereas the mean chromosome lengths are respectively, 21.8, 17.7, 15.63, 14.6, 13.7, 12.7, 11.3 and 9.4 μ m due to their length.

Late stage: In this stage, four cells were observed in Table 2. The chromosome length changed between 20 μ m and 7 μ m with 1.5 and 1.33 index as longest and shortest ones at the late stage of metaphase, respectively. While the total longest chromosome was displayed as 99 μ m, the shortest one had 89 μ m. The mean total lengths appeared to be 16.8, 14.25, 12.8, 11.1, 9.8 and 7.5 μ m at this stage, respectively.

Comparing early and late stages: The comparison of the stages were summarized in Table 3. The stages showed that the chromosome length getting shorter and shorter while advancing the periods. On the other hand, the satellite of chromosomes showed that the related chromosome had different folding pattern on the length. So, the chromosome karyotype had a length differentiation according to their satellite exists of chromosomes. This implies that chromosome karyotype has to be analysed at the shortest folding position of chromosomes and the index was not able to using for diagnosis of chromosome karyotype in the early stage. In this case, the total folding rate can be calculated early stage/late stage of metaphase of mitosis, which is changing

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Chromosome no. and arm length (μ m)																Tota			
No. Cell	1		2		3		4		5		6		7		8		Length µM		
	L	S	L	S	L	s	L	S	L	S	L	S	L	s	L	S	<i>r</i>		
1	12	10	10	10	9	7	10	5	10	5	10	4	10	4	7	5	129		
2	10	6	10	5	8	5	7	6	7	5	6	5	8	2	5	4	189		
3	14	12	13	7	5x8*	9	13	7	10	8	10	7	9	5	5	3	145		
4	13	10	12	6	8	6	8	6	7	6	7	3	7	3	6	5	113		
5	14	11	10	6	9	5	8	5	7	5	8	5	6	4	5	4	112		
6	12	7	11	6	9	6	7	6	7	5	7	4	7	3	5	3	105		
Mean	12	9	11	6	9	6	8	5	8	5	8	4	7	3	5	4	132		
Arm ratio I/s	1.34 s		1.34 1.64 1.4		8	1	.51	1.40		1.70		2.22		1.38					

Table 1: Mean of chromosome arm lengths (µm) and arm ratios at early stage of metaphase in Allium cepa L.

Table 2: Mean of chromosome are lengths (μ m) and arm ratios at late stage of metaphase in Allium cepa L.

	Chromosome no. and arm length (μ m)															Total	
No. Cell	1		2		3		4		5		6		7		8		Length µM
	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	•
1	9	7	8	7	7	6	7	6	7	5	3x5*	3	7	4	5	3	990
2	8	6	8	5	7	6	7	6	3x4*	5	5	4	5	4	4	3	90
3	11	6	10	5	7	5	7	4	6	3	5	4	6	2	5	3	89
4	12	8	9	5	8	5	7	6	7	4	6	5	6	2	4	3	98
Mean	10	6	8	5	7	5	7	5	6	4	6	3	6	3	4	3	94
Arm ratio I/s	1.47		1	.59		1.32		1.27	1.	58	1.5	57	1	.82		1.50	

Table 3:	The comparison of mean of chromosome arm lengths (μ m) and arm ratios in Allium cepa L.																
	Chromosome no. and arm length (μ m)													Total			
No.	No. 1 Cell		1 2		3		4		5		6		7		8		Length µM
Cell																	
	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	
E.S.	12.5	9.3	11	6.7	9.3	6.3	8.8	5.8	8.0	5.7	8.0	4.7	7.8	3.5	5.5	4.0	132.16
L.S.	10	6.8	8.8	5.5	7.3	5.5	7.0	5.5	6.8	4.3	6.0	3.8	6.0	3.3	4.5	3.0	94
Mean	11	8	10	6	8	6	8	5	7	5	7	4	7	3	5	3	113
Arm ratio I/s	1.35		1	.62	1	.41	1	.42	1.	47	1	.63	2	.08	1.	44	

*Arm ratios include sattelite L: long S: short E. S: Early stage L.S: Late stage

between 1.01 to 2.16 due to the base of the smallest total length of chromosomes. The karyotype of chromosomes were designed as showing the telomer and centromer sides. It is obvious that the analyzing of closer chromosomes makes conflict the analyse (Elci, 1982). Because the longer chromosomes laps each other with unclear focus changing due to their magnification and stage differences.

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