Cytological Studies of Some Varieties of Musk Melon with Special Reference to their Relationship

R. P. Chandola, M. P. Bhatnagar and Miss Indu Tokuta

Botanical Laboratory, Durgapura, Jaipur, India

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Among angiosperms the Cucurbitaceae is one of the most important families and consists of a good number of genera. The members of this family are widely distributed in India and the different species occur both in the temperate and tropical regions of this subcontinent. This is the only family which provides the maximum number of vegetables to this country and importance of some of the members of this family as medicinal plants also cannot be ignored.

In the Cucurbitaceae, *Cucumis melo* (musk melon) is of prime importance as far as its abundance in prevailing varieties is concerned. No thorough cytological study on the genus has yet been taken up and a few counts by Yamaha and Suematsu (1956), Shifriss (1941) and Bhaduri et al. (1947) have been made. Accordingly these records show that in musk melon alone the numbers $2n=20, 22$ and $24$ exist and that the species *Cucumis melo* is characterised by low numbers of chromosomes as these. A study of karyotypic data provided by the varieties dealt with presently shows that some types are characterised by symmetrical karyotypes and few others by asymmetrical ones and thus an investigation of the status of this genus from the point of view of cytology seems to be an important study.

**Materials and methods**

The material for this study was collected from various localities of Indian Plains and some were of Russian stock (Figs. A and B). Their varietal names with their respective sources are given in Table 1.

![Fig. A](image)

**A**, seeds (from left to right) of Amritsari, Kharda, Durgapura Madhu, Lucknow and Local.

![Fig. B](image)

**B**, seeds (from left to right) of Ich-kzyl-331 Tashlaba 562, Kock-588, Shakar palk and Kob-ten-1087.
The Russian material was passed on to us by the Botany Div. of the Indian Agricultural Research Institute, New Delhi to whom our thanks are due.

Table 1. Name of varieties and their sources

<table>
<thead>
<tr>
<th>Name of variety</th>
<th>Sources (Locality)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Local</td>
<td>Bhankrota, Rajasthan</td>
</tr>
<tr>
<td>2. Kharda</td>
<td>Tonk, Rajasthan</td>
</tr>
<tr>
<td>3. Durgapura Madhu</td>
<td>Durgapura, Rajasthan</td>
</tr>
<tr>
<td>4. Lucknow</td>
<td>Lucknow, U.P.</td>
</tr>
<tr>
<td>5. Amritsari</td>
<td>Amritsar, Panjab.</td>
</tr>
<tr>
<td>6. Ich-kzyl</td>
<td>Russian</td>
</tr>
<tr>
<td>7. Tashlabab</td>
<td>Russian</td>
</tr>
<tr>
<td>8. Kock-588</td>
<td>Russian</td>
</tr>
<tr>
<td>9. Shakar-Palk (White flesh)</td>
<td>Russian</td>
</tr>
<tr>
<td>10. Kob-ten-1087</td>
<td>Russian</td>
</tr>
</tbody>
</table>

For root tips, seeds were germinated in petridishes in the laboratory and as well as in suitable enamel dishes with saw dust both at 20°C. In all cases healthy roots were obtained on the third day. For study of somatic chromosomes root tip squashes of material fixed in 20% aceto-alcohol and stained with aceto-orcein were prepared. Before actually putting the material on slide the root tips were kept in a mixture of 2% aceto-orcein plus a drop of HCl for 15 minutes in each case. This technique proved quite satisfactory. For meiotic chromosomes only the aceto-orcein smear method was found to be suitable. A pretreatment with Carnoy's fluid for a few minutes followed by the thorough washing with distilled water was helpful in securing good results.

Good divisions were found between 9 to 9-30 a.m. in root tips and between 10-11 a.m. in case of flower buds.

Figures were drawn at table level at approximately 2,500× using a Leitz compensating eyepiece of 10 and 1.3 apochromatic objective with a condenser of 1.2.

Observations

Somatic chromosome number is variable in two varieties viz. Lucknow (2n=22) and Kob-ten-1087 which has 2n=20. The rest of eight varieties bear the same somatic number as 2n=24 and corresponds to the counts made by Yamaha and Suematsu (1936), Shifriss (1941) and Bhaduri et al. (1948). Size of the chromosomes in these varieties is also very variable ranging from medium in Kock-588 to short types of chromosomes in Local. Primary constrictions at different positions median, sub-median and terminal could not be detected with greater accuracy as the general size of these chromosome complements is small. A few chromosomes in some of the complements do show the constriction but these were not enough to study this aspect of the chromosome morphology. The sizes of haploid number of chromosomes is given in Figs. 15-23. Heteromorphic pair of chromosomes, one in each complement, is noticed in each of these varieties and presumably represents the sex-chromosomes of this species. Nuclei with altered chromosome numbers have not been recorded in any of these varieties.
Var. Kharda Twenty-four chromosomes are found to be present in the normal somatic complement (Fig. 1). Chromosomes are medium sized and accordingly four groups of different sizes can be recognized: 1) one pair of 9 μ, 2) four pairs of 8 μ, 3) one pair of 7 μ and 4) five pairs of small chromosomes of 6 μ. The two heteromorphic chromosomes are of 14 μ and 8 μ sizes. The size of range thus varies from 6.0 μ to 14.0 μ. The various distinguishable sizes of the complement are shown in Fig. 15.

Var. D. Madhu Somatic chromosome number for this variety was found to be 2n=24 (Fig. 3). Chromosomes are mostly medium in size and
vary from 5 μ to 9.5 μ and five groups of these can be recognized (Fig. 16): 1) one pair of 5.5 μ, 2) one pair of 7.5 μ, 3) four pairs of 6.5 μ, 4) four pairs of 5.5 μ and 5) one pair of 5 μ. The heteromorphic chromosomes are of 8.5 μ and 5.5 μ (Fig. 16).

**Var. Lucknow** Twenty-two chromosomes are present in the complements of the normal somatic nuclei (Fig. 2). Chromosomes are medium sized and accordingly 6 groups of different sizes can be recognized: 1) one pair of 8 μ, 2) three pairs of 7 μ, 3) three pairs of 6 μ, 4) one pair of 5.5 μ, and 5) one pair of 5 μ, and 6) one pair of 4 μ. The heteromorphic chromosomes are of 8 μ and 4 μ. The size range of whole complement lies between 4 μ and 8 μ. These six morphologically distinguishable types are shown in Fig. 17.

**Var. Ich-Kzyl of Kzvekistan-33-1** The somatic complements contain 24 chromosomes (Fig. 5). The normal somatic complement chromosomes are medium sized and the 4 groups of different sizes can be recognized: 1) 4 pairs of 8 μ, 2) two pairs of 6.5 μ, 3) two pairs of 6 μ, and 4) three pairs of 4 μ. The heteromorphic chromosomes are of 12 μ and 6 μ. The size range varies between 4 μ and 12 μ. The morphologically distinguishable types of this complement are given in Fig. 18.

**Var. Tashlaba-562** The somatic chromosome number has been found to be 24 (Fig. 7). Chromosomes are medium sized and five groups of different sizes can be recognized: 1) two pairs of 10 μ, 2) one pair of 9 μ, 3) four pairs of 8 μ, 4) two pairs of 7 μ and 5) two pairs of 6 μ. The heteromorphic chromosomes are of 7 μ and 6 μ. The morphologically distinguishable types can be seen in Fig. 19.

**Var. Kock-588**. The twenty-four chromosomes can be grouped in six different classes according to size. 1) two pairs of 12 μ, 2) three pairs of 9 μ, 3) one pair of 8 μ, 4) two pairs of 7 μ, 5) two pairs of 6 μ, and 6) one pair of 5 μ. The heteromorphic chromosomes are of 12 μ and 6 μ. The size range of the whole complement is 12 μ to 5 μ. The morphologically distinct types are shown in Fig. 20.

**Var. Shakar Palk (white flesched)** The normal somatic chromosome number for this variety has been determined to be twenty-four (Fig. 6). Chromosomes are medium sized and four groups of different sizes can be recognized: 1) one pair of 7 μ, 2) four pairs of 6 μ, 3) two pairs of 5 μ, and 4) four pairs of 4 μ. The heteromorphic chromosomes are of 8 μ and 6 μ. The size range varies between 4 μ to 8 μ. These morphologically distinct types can be seen in Fig. 21.

**Kob-Ten-1087** Twenty chromosomes are found to be present in the normal somatic complement (Fig. 9). Chromosomes are medium sized and accordingly six groups of different sizes can be recognised: 1) one pair of 8 μ, 2) two pairs of 7 μ, 3) one pair of 6 μ, 4) two pair of 5.5 μ, 5) one pair of 5 μ, and 6) two pairs of 4 μ. The heteromorphic chromosomes are
of 6μ and 4μ sizes. The size differences marked in this complement can be seen in Fig. 22.

Local The normal somatic chromosome number has been found to be 2n=24 (Fig 8). Chromosomes are generally very small sized and four

Figs. 15-23. Diagramatic representation of the haploid autosomes plus two sex-chromosomes in varieties of musk melon. The last two are the sex-chromosomes in each case. 15, Kharda. 16, Durgapura Madhu. 17, Lucknow. 18, Ich-kzyl of Kzvekistan-331. 19, Tashlaba-562. 20, Kock-588. 21, Shakar palk (white flesh). 22, Kob-ten-1087. 23, Local.

groups of different sizes can be noticed: 1) four pairs of 5μ, 2) four pairs of 4μ, 3) two pairs of 3μ, and 4) one pair of 1μ. The heteromorphic chromosomes are of 5μ and 2μ sizes. The size range varies from 1μ to 5μ. The morphologically distinguishable types that are present in this complement are given in Fig. 23.

Meiosis Meiosis was worked out in detail for the varieties Durgapura Madhu, Amritsari and Lucknow. Kharda and Local could not be studied for want of good plates and availability of few flower buds only. Available metaphase plates in these three materials confirmed the counts as n=12 in Durgapura Madhu and Amritsari and 2n=11 in Lucknow (Fig. 2). In case of Russian varieties, germination was very poor on the field and thus material for meiosis could not be secured for the five varieties.

In Durgapura Madhu, the chromosome number n=12 was noticed in the MI and TI stages (Figs. 10 and 11).

Variety Amritsari also showed 12 bivalents of different sizes at MI (Fig. 12) and 12 univalents at TI (Fig. 14).

Variety Lucknow showed the presence of 11 bivalents of different sizes at MI (Fig. 13) corresponding to the 2n=22 reported previously in the mitotic metaphase (Fig. 2).
In the above mentioned instances secondary association of bivalents at MI was observed to occur in the following patterns (Table 2).

**Table 2. Secondary association in MI of varieties of Durgapura Madhu, Amritsari and Lucknow of musk melon (**C. Melo**)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Types of association</th>
<th>No. of times observed</th>
<th>Units of grouping</th>
<th>Max. assocn.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durgapura Madhu</td>
<td>12(1)</td>
<td>nil</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Amritsari</td>
<td>12(1)</td>
<td>nil</td>
<td>—</td>
<td>Max.</td>
</tr>
<tr>
<td>Lucknow</td>
<td>11(1)</td>
<td>nil</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Maximum association was found to be 4 groups in D. Madhu, 5 groups in both Amritsari and in Lucknow. In a closely allied species *Cucumis sativus* L. Bhaduri *et al.* (1948) have found a maximum association 2(2)+1, the secondary basic number being three. *Cucumis sativus* L. incidently, is alone having the lowest basic number as n=7 in the whole family.

**Discussions and conclusions**

From Figs. 1–9 it will be seen that the chromosome number in the *Cucumis melo* L. species having as many as ten varieties varies in two species viz. Lucknow (2n=22) and Kob-ten-1087 (2n=20). This seems to be a case of aneuploidy within a species having members with n=10, n=11 and n=12 chromosomes. Bhaduri *et al.* (1947) have reported a aneuploid series in the family Cucurbitaceae as n=7, 10, 11, 12, 13...24. The present investigations also reveal that the number n=10, 11 and 12 is also present in this species. The number does not only vary within the various genera of this family but also within a species such as found in *Cucumis melo*.

It is evident from the foregoing observations that numerical polyploidy has not played any significant role in the evolution of new varieties in the species of *Cucumis melo* though there is preponderence of evidence of polyploidy in different members of the family Cucurbitaceae. In *Cucumis sativus*, Bhaduri *et al.* (1947) have shown on the basis of study of secondary association between bivalents in the PMCs that the basic number 7 is derived from three by secondary polyploidy. In *Cucumis melo* varieties the lowest secondary basic number is found to be four in variety Durgapura Madhu (Table 2). Absence of multivalents in this variety at meiosis rules out the possibility of their being of autopolyploid origin, hence it is quite
likely that these varieties also originated as secondary polyploids. However, this will need more study before reaching any definite conclusion.

In *Cucumis melo* there are no indications of duplications of chromosomes in the different varieties of this species. In the absence of such evidence, only numerical and structural changes in the chromosomes can presumably give rise to new varieties in this species. On this basis varieties Lucknow (2n=22) and Kob-ten-1087 (2n=20) have originated through reduction of 2 and 4 chromosomes respectively in the normal complement of 2n=24 generally found in the other varieties. Such numerical changes coupled with structural changes causing size variations in the different complements of various members is evident by these studies. Though this suggestion of relationship is entirely hypothetical, but it does indicate a place where experimental studies should be attempted. A partial support to the view of production of aneuploid gametes is lent by all those related species with unrelated chromosome numbers which are of widespread occurrence in the plant kingdom. Examples are found in *Primula* (Brunn 1932), *Iris* (Simonet 1934) and *Grepis* (Babcock 1947). Studies of these genera reveal that addition or reduction of chromosomes in part or full are a means of species formation. How far such numerical alterations too play a distinct role in producing new varieties is yet to be worked out in musk melon. There are distinct pattern of morphological variations in the different varieties of this species including the leaf size and shape, fruit size, shape and colour, and size of seeds. It may also be pointed out that the normal pairing behaviour and good fertility in all the varieties examined presently show the very stable and balanced nature of the chromosome complements.

From the studies of karyotypes in the *C. melo* varieties it has been observed that when size of chromosomes is taken in consideration there are always two chromosomes left in each complements which do not form a pair due to their heterogenous sizes. These are the sex-chromosomes in the different varieties and have been shown as the last two chromosomes in the diagramatic representation of the haploid genome in Figs. 15-23, the bigger being X and smaller Y. In Cucurbitaceae and other dioecious flowering plants also sex-chromosomes have been reported. Nakajima (1937) has shown the presence of sex-chromosomes in *Trichosanthes japonica* (snake gourd). Bhaduri et al. (1947) have also reported presence of sex-chromosomes of XY type in the *Coccinia indica* (ivy gourd) another member of Cucurbitaceae.

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**References**


