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CULTIVATED CUCURBITS AND THEIR WILD RELATIVES IN INDIA

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Cucurbits are a highly evolved group of plants, widely cultivated as vegetables and fruits. Eighteen out of about 100 species known to occur in India, are cultivated. Many wild species and weedy relatives are important and could be utilized for improving the cultivated types through breeding approaches. The origin, distribution, classification, morphology and climatic adaptation of cucurbits have been reviewed. A detailed account of the available diversity, distribution pattern and economic uses in respect of cultivated cucurbits has been enumerated. The role of wild relatives for improving the potential of cultivated types has been emphasized.

There are 110 genera and 640 species in the family Cucurbitaceae (Willis, 1982) which are distributed primarily in the warmer parts of the world. In India, about 100 species of cucurbits under 36 genera are known so far (Chakravarty, 1982). Out of which, 25 species are endemic and eighteen species belonging to 10 genera are commonly cultivated as vegetables and fruits. These include pumpkin, squash, vegetable marrows, gourds, melons, watermelons, cucumber and several lesser known crops. The most important nutritional contribution of the fruits are vitamins and minerals especially vitamins A and C. The food value and nutritional quality of different Indian cucurbits revealed their usefulness for various purposes (Gopalan *et al.*, 1982 or Seshadri, 1986). These could be used for food either fresh, cooked, pickled, candied and curried. The young leaves and flowers of several species are edible and rich source of vitamins and minerals. The species with fruits having a hard, tough rind are used for containers, cutlery, musical instruments and ornaments etc. In this paper, an attempt has been made to review the available information on origin, distribution, growth habit and economic uses of cultivated cucurbits and their wild relatives occurring in India.

Classification, Origin, Distribution, Morphology and Climatic Adaptation

Taxonomy and classification

The taxonomy and classification of this group (Family - Cucurbitaceae) including infra-specific categories has been discussed by several workers (Cogniaux, 1881; Jeffrey, 1980; Chakravarty, 1982). The seed morphology of 24 species, belonging to 22 genera of Indian cucurbits which was studied by Chakravarty and Hore (1979) could be used as an aid to identify the species. However, the realistic classification of the cultivated species and their forms is too difficult to ascertain from seed morphology because of wide range of variations within the species. This could possibly be due to the domestication, selection and gradual improvement of the crop.

Origin and distribution

The distribution of this group of plants is found almost throughout the world either in indigenous or introduced form. The centres of origin of various cultivated species are located mainly in Asia, Africa and American continents (Zeven and Zhukovsky, 1975; Whitaker and Bemis, 1976; Esquinas-Alcazar and Gulick, 1983). The study of chromosome number of various species of both cultivated and wild cucurbits was done by different authors from time to time which has been compiled and well documented by Fedorov (1974). The cytological investigations also helped in recognising the centres of diversity of *Cucumis* groups bearing chromosome number 2n = 14 and 2n = 24 (Jeffrey, 1980.). Similarly, the earlier concept about the relationship between *Citrullus lanatus* and *Praecitrullus fistulosus* was disproved by cytological studies (Khoshoo and Vij, 1963).

The cultivated species of cucurbitaceae include plants of both New and Old World origin (Esquinas-Alcazar and Gulick, 1983). Genus *Cucurbita* is believed to have originated from central Mexico and west-central part of Latin America as evidenced from the fossil records (Whitaker, 1983). There are 26 species of *Cucurbita* distributed throughout the world (Whitaker and Bemis, 1976). Out of these, 5 species are domesticated and cultivated of which 4 are popularly cultivated in India.

Morphology

Most cucurbits are trailing herbs or undershrubs with tendrils. Habit wise, these are either monoecious or andromonoecious. But gynomonoecy, androgynomonoecy, androecy, gynoecy and hermophrodite flowers are also found in some species. Dioecious habit is also prevalent in some of the species. Thus, they are open pollinated, self-compatible and genetic variation exists within a single cultivar. Different species vary in shape and size of their leaves besides, flower size and colour, fruit shape, size, colour variations, dehiscence and their seed morphology.

Climatic adaptation

The growth and development of different species show varying degrees of sensitivity to temperature and humidity. Melons and watermelons prefer hot dry climates. Cucumbers grow well in moderate warm conditions. Both have disease problems in areas of high humidity. On the contrary, the species of *Cucurbita* generally are well adapted to low and cool temperatures. In Indian conditions, *Sechium* grows very well between 800 to 2000m altitude. However, the germplasm of various cucurbits collected from the north-eastern region have shown wider adaptability.

Cultivated cucurbits

Among the different species of cucurbits, *Cucurbita* is the only dominant genus with several major cultivated species, namely, *Cucumis*, *Citrullus*, *Momordica*, *Luffa*, *Lagenaria*, *Benincasa*, *Praecitrullus*, *Trichosanthes* and *Sechium* (Table 1). The diversity available in important cucurbits, their distribution pattern and the economic uses are briefly given species-wise.

Table 1. Major Cucurbitaceous crops in India

Species	Common English name	Native area*	Chromosome number (2n)
Benincasa hispida (Thumb.) Cogn.	White gourd	Asian subtropics	24 (Varghese, 1973)
Citrullus lanatus (Thunb.) Mats. & Nakai	Water melon	South Africa	22 (Shimotsuma, 1958)
Cucumis melo L	Melon	Tropical and South Africa	24 (Vasil, 1962)
Cucumis sativus L	Cucumber	India	14 (Roy and Mishra, 1962)
Cucurbita ficifolia Bouche**	Fig leaf gourd	Mexico, Central & Northern South America	40 (Whitaker, 1956)
Cucurbita maxima Duch. ex Lam.	Winter squash	Northern South America & Central America	40 (Bhaduri and Bose, 1947).
Cucurbita moschata (Duch. ex Lam.) Duch. ex Poir.	Pumpkin	Mexico, Central America	40 (Pearson *et. al.* 1951)
Cucurbita Pepo L	Marrow pumpkin	North America, North of Mexico city	40 (Whitaker 1930, 1956)
Lagenaria siceraria (Molina) Standl.	Bottle gourd	Africa, the Americas	22 (Whitaker, 1930)
Luffa acutangula (L) Roxb.	Ribbed gourd	India and East Asia	26 (Bhaduri and Bose *l.c.*)
Luffa cylindrica (L) M. Roem.	Sponge gourd	Tropical world especially Japan and Brazil	26 (Whitaker, 1933)
Momordica charantia L	Bitter gourd	South & SE Asia	22 (Riley, 1960)
Momordica cochinchinesis (Lour.) Spreng.**	Sweet gourd	SE Asia & Pacific	- -
Momordica dioica Roxb. ex Willd.**	Prickle gourd	Subtropical Asia	28 (Richharia and Ghosh, 1953)
Praecitrullus fistulosus Pang.	Round melon	India	24 (Khoshoo and Vij. *l.c.*)
Sechium edule (Jacq.) SW.***	Chayote, Chow chow	Tropics and Latin America	28 (Varghese, *l.c.*)
Trichosanthes anguina L	Snake gourd	South & SE Asia	22 (Nakajima, 1936)
Trichosanthes dioica Roxb.	Pointed gourd	Karnataka & West Bengal in India	22 (Bhaduri and Bose, *l.c.*)

* After Zeven and Zhukovsky (*l.c.*), Esquinas-Alcazar and Gulick (*l.c.*)
** Perennial
*** Semi-Perennial

Winter squash (*Cucurbita maxima*)

Among the cucurbits, *Cucurbita maxima* is noted for its extremely rich diversity. Polymorphic variations in the fruit morphology (shape, size, both primary and secondary skin colour, surface, weight etc.) are remarkable within the species itself. Variations are much prominent in cultivars, possibly due to the result of selection (Whitaker and Robinson, 1986). In the course of time, the species was introduced in the old world countries. India and Myanmar (Burma) are considered secondary centres of diversity for *Cucurbita maxima* (Equinas-Alcazar and Gulick, 1983). Remarkable variations were observed in fruit shape, size, external surface, shell thickness, skin and flesh colour of *Cucurbita maxima* that are grown in north-eastern region of India. It grows in different ecological situations from tropical to temperate climate. In Nagaland, some old obsolete varieties and primitive cultivars are still existing which seem to be the rare and exceptionally useful material.

Pumpkin (*Cucubita moschata*)

Diversity in *Cucurbita moschata* is somewhat less than that observed in *C. maxima* in India. Apparently, it differs from *C. maxima* in respect of presence or absence of stem bristles, leaf texture, nature of peduncle and calyx morphology. Fruits in *C. moschata* are usually oblong and constricted at the middle. Based on seed size and margin, species is readily distinguishable from *C. maxima*. The species is cultivated throughout tropical and sub-tropical regions of India.

Marrow pumpkin (*Cucurbita pepo*)

Cucurbita pepo is characterised by its 5-angulate, grooved, hard peduncles and relatively smaller fruit size than other *Cucurbita* species. Variations are prevalent within the species in respect of fruit shape and colour. Unripe fruit is mostly preferred as vegetable during the rainy season when it is available. The species thrives well under tropical climatic conditions.

Fig leaf gourd (*Cucurbita ficifolia*)

This perennial, short-day species is basically a Mexican species which was introduced in the Meghalaya state where it naturalised very well. Though human consumption of the fruits is very limited in Meghalaya, it is largely fed to the domestic animals like pigs, cows etc. The species is least variable and mostly restricted in its habitat.

Cucumber (*Cucumis sativus*)

Out of 6 species of *Cucumis* found in India, *Cucumis sativus* is widely cutlivated. Cytological studies revealed that the species under the genus *cucumis* belong to two distinct geogrphically isolated groups, i.e. Asiatic group and African group (Seshadri 1986). Species bearing chromosome number 2n = 14 are all of Himalayan origin while species of 22n = 24 are basically originated from tropical and south Africa. Cucumber *(Cucumis sativus)* having chromosome number 2n = 14 originated in India. This species has been cultivated since 3000 years (De Candolle, 1882) all over India and has two forms (i) creeping form - cultivated in the fields

during hot season and (ii) climbing form-cultivated during the rainy season. Morphologically, they differ in fruit size.

The closely related wild species (*Cucumis hystrix* Chakrav.), also grows in Meghalaya which, however, may be a weedy form of the cultigen. This creeping plant with small, echinate, oblong fruit with bitter taste can be a valuable material for breeding purpose with the cultivated cucumber, since they are well adpated in wild habitat at 900-1500 m altitude and resistant to diseases and pests.

Muskmelon (*Cucumis melo*)

This species is also widely cultivated in India. Its centre of origin is supposed to be Africa (Zeven and Zhukovsky, 1975) where many wild species of the genus frequently occur. Domestication of muskmelon may have occurred independently in India (Esquinas-Alcazar and Gulick, 1983) especially, north and central India where many forms of melons differing in size, skin and pulp colour and taste are cultivated.

Watermelon (*Citrullus lanatus*)

This species has originated in tropical and west Africa and gradually spread to India in very early times. It is now the centre of diversity for cultivated forms. Its wild form occurs in semi-desert and sandy areas of Kalahari desert (Seshadri, 1986). Botanically, the species has several forms and the variation exists in size, shape, colour and sweetness of the pulp.

White gourd (*Benincasa hispida*)

The centre of origin and diversity of white gourd or wax gourd is south-east Asia and Indo-China and it is distributed from Japan to India. This monotypic species is a monoecious vine bearing large green fruits, globose-cylindrical in shape and covered with thick epicuticular wax. It is cultivated in tropical and sub-tropical regions of India and has a wide variability among its cultivars especially, in fruit size and shape and seed colour. It is widely used in northern India in preparing dry sweetmeat from the mature fleshy parts of the fruits. In Meghalaya, the species is cultivated in the *jhoom* land which gives a very good yield.

Bottle gourd (*Lagenaria siceraria*)

Archaeological records indicated that this species was present in Peru (Latin America) around 12,000 B.C. (Esquinas-Alcazar and Gulick, 1983). There is a good evidence of its origin in Africa (Jeffrey, 1980). This white-flowered gourd has a long history of cultivation in both the New and Old World and perhaps a very important crop for the primitive societies which is documented by well preserved remains of seeds, peduncles and occasionally intact fruits. It is widely cultivated in the warmer parts of India as a vegetable. The hard fruit-shells when ripe are used as containers for storing liquids and food, as eating utensils and for musical instruments like *Sitar* and *Veena*. Extensive variability exists in this species in respect of shape, size, colour and weight of the fruit in the north-eastern region of the country.

Ribbed gourd, sponge gourd (*Luffa spp.*)

The probable centre of origin and the primary gene centre for *Luffa* is in India. Out of total 9 species present all over the world, 7 occur in India. Among them, *Luffa acutangula* and *L. cylindrica* are commonly cultivated. They are monoecious vines bearing ridged or smooth fruits, which contain many black seeds at maturity. Young fruits are used as a cooked vegetable, while dried skeletonised fruits are used as bath-sponge. Taxonomically, there are two varieties of *Luffa acutangula* i.e. var. *acutangula* and var. *amara* (Chakravarty, 1982) and they have been differentiated on the basis of size and shape but variability occurs among cultivars in their size and taste.

Bitter gourd (*Momordica charantia*)

This species has originated in the tropics of Old World and occurs widely in the tropics of Asia. A monoecious vine, variable in the form of its fruits. The fruit is characterized by its tuberculate-muricate skin and the sculptured seed surface. Young fruits are used in the tropics as a vegetable, in pickles, curries and salads. It is also eaten during an epidemic of small-pox as it is supposed to have a preventive effect. In India, *M. charantia* var. *muricata* is often seen in wild condition also, while the var. *charantia* is fully domesticated. The fruits and seeds of bitter gourd exhibit wide variations within the Indian sub-continent.

Sweet gourd (*Momordica cochinchinensis*)

This species is an Indo-Malayan species extending its distribution upto Pacific Islands. The fruits are generally small and cultivated in kitchen gardens during the winter. The green fruits are a favourite vegetable of the people of north-east India.

Prickle gourd (*Momordica dioica*)

Prickle gourd is thought to have originated in India and gradually spread to adjacent Asian countries, namely, Burma, Sri Lanka and China. The species is characterized by its tuberous roots which are used as a sedative during fever. The green fruit is extensively used as a vegetable by cooking or frying. The plant usually propagates through root-stock which can establish easily.

Round melon (*Praecitrullus fistulosus*)

Round melon (*Tinda*) is confined to north and north-western regions of India and Pakistan which seems to be the centre of origin of the species. Morphologically and cytogenetically, the taxon is different from its allied species *Citrullus lanatus*. The species is cultivated in north and north-eastern regions of India for the fruits which are used as vegetable.

Chayote or chow-chow (*Sechium edule*)

This is commonly known as squash in India which is entirely different from squash of western countries. For the people of western countries squashes are the tender/growing fruits of *Cucurbita* which are much relished. *Sechium* is monotypic

genus and its centre of origin and diversity is in tropical America. This introduced species is cultivated in India especially in sub-tropical to temperate hilly region. This monoecious vine having one-seeded fruit is an unusual character among the cucurbits. The unripe fruits and tender shoots are used as a vegetable which flourishes during the rainy season. Large tuberous starchy roots are used as food. The fruits, which contain 92% water have a low nutritive value. It grows abundantly throughout the eastern Himalayas, both as cultivated and wild. Considerable variability exists in the fruits in size, shape, colour and surface. The species can propagate either through mature fruit (viviparous germination) or viable root-stock.

Snake gourd (*Trichosanthes anguina*)

This species is cultivated in India during the rainy season and its centre of diversity extends from India down to Australia. The fruit is characteristically long (upto 1.5 m), pipelike, fleshy, often twisted with 7-8 white stripes along its length when green. The young fruit is largely used as a vegetable either boiled or in curries. Variation in the fruits i.e. length, diameter, colour and number of stripes occurs within the species.

Pointed gourd (*Trichosanthes dioica*)

India is the centre of diversity of pointed gourd. It is extensively cultivated in the warmer parts of the country. Plants are dioecious and normally grown in rainy season. The fruits are commonly used as vegetable. Several cultivated forms differing in size, shape and markings of the fruit are common in India. The occurrence of wild and semi-wild forms in the plains of Assam indicates that it might have originated in this area.

WILD RELATIVES OF CUCURBITS

There are several wild relatives of cultivated cucurbits which have the potential to contribute specific desirable genes for bringing spectacular improvements in the cultivated cucurbits. Wild relatives of major cultivated cucurbits and the details about their distribution, reproductive behaviour, chromosomal status and other characteristics are given in Table 2. A few species, namely, *Cylanthera pedata*, *Gymnopetalum cochinchinensis* and *Hodgsonia macrocarpa* are important but still underexploited and need improvement for large scale domestic use. Interspecific crosses between the cultivated and their allied wild species or domestication of naturally occurring wild species through the manipulation of different cultural practices offer a good scope for developing disease resistant and stress tolerant varieties. Indeed, the wild relatives of cultivated species could play an important role in this respect because these can adapt themselves and survive well against natural adversities. The genes responsible for these traits are still untapped and need to be incorporated in the cultivated types through appropriate breeding procedures

Table 2. Wild relatives of major cultivated Cucurbits in India

Wild species	Distribution	Sex type	Chromosome No. 2n) with authority	Remarks
1. *Citrullus colocynthis* (L.) *Schrad.***	Punjab, Rajasthan, Andhra Pradesh, Tamilnadu	Monoecious	22 (Whitaker, 1933	Essentially a desert plant; readily crosses with *C. lanatus*
2. *Coccinia grandis* (L) Voigt.****	Rajasthan, U.P., Bihar, W.B., Gujarat, A.P., Orissa, Tamilnadu, Kerala	Dioecious	22 (Bhaduri and Bose, *l.c.*)	Though synonomous with cultivated 'Kundri' (i.e. *C. indica* W.A.) but differs in leaf lobation, texture and fruit size. However, the wild and cultivated species are allied and closely related with each other.
3. *Cucumis hystrix* Chakrav.*	Meghalaya, Mizoram	Monoecious	–	An endemic species of north-eastern region of India. Very iimited occurrence. Normally found over 900 m altitude. Resistant to pests and disease.
4. *Cyclanthera pedata* (L) Schrad.*	Medium altitude of Meghalaya and Uttar Pradesh	Monoecious	32 (Whitaker, 1933)	Basically, the species is exotic. This semi-wild fruit has been introduced in India and domesticated very well in medium to high altitude (800 to 1500m) and gives relatively productive yield.
5. *Gymnopetalum cochinchinesis* (Lour.) Kurz.*	Andhra Pradesh, Arunachal Pradesh, Bihar, Assam, Manipur, Meghalaya, Sikkim, Tripura U.P. and West Bengai	Monoecious/ Dioecious	22 (Islam and Saha, 1951)	Wildly growing species and may be considered as underutilized plant. The unripe bitter fruits used rarely as vegetable by the tribes of north-eastern region.
6. *Hodgsonia macrocarpa* (Bl.) Cogn.**	Arunachal Pradesh, Meghalaya Mizoram and Sikkim	Dioecious	–	Grows wildly at lower altitude or foot hills. This under-exploited, less known plant yields oil from its seeds, but the fruits pulp is poisonous
7. *Trichosanthes cucumerina* L*	Throughout India	Monoecious	22 (Roy and Mishra, l.c.)	Closely related to cultivated *T. anguina*,, but differs in fruit length, shape and absence of stripes on fruit surface

* Annual
** Perennial
*** Semi-perennial

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