

Diversity of fruits in *Cucurbitaceae* in Northern India

Shyam Vir Singh Chauhan✉ and Seema Chauhan

Academy of Life sciences, Kaushalpur, Agra-282005, India

E-mail: svsc071241@gmail.com

ORCID ID 0000-0002-3915-4563; ORCID ID 00000-0002-7860-5339

✉ svsc071241@gmail.com

Abstract.

Aim. The study of the morphological diversity of fruits in some members of the family *Cucurbitaceae* from Northern States of India was aim of these researches. **Methods.** Plant specimen and their germplasm were collected from various states of Northern India. Herbarium specimens were prepared by standard procedure. The studies were performed using the checklists of the *Cucurbitaceae* of India published by C. Jeffrey (1980, 1982), H. L. Chakravarty (1982) and S. S. Renner & A. K. Pandey (2013). **Results.** In India, a number of major and minor cucurbits are cultivated in several commercial cropping systems and also as popular kitchen garden crops. Cucurbits share about 5.6 % of the total vegetable production of India. **Conclusions.** The fruits of studied cucurbits (family—*Cucurbitaceae*) from Northern States of India exhibit great deal of diversity in shape, size, colour of the rind and flesh as well as many consumption ways for both food and medicinal purposes.

Key words: pepo, watermelon, muskmelon, ash gourd, bitter gourds, snake gourd, pumpkin.

Різноманіття плодів *Cucurbitaceae* у Північній Індії

Шям Вір Сінгх Чаухань✉, Сіема Чаухань

Академія наук про життя, Каушалпур, Агра-282005, Індія

E-mail: svsc071241@gmail.com

ORCID ID 0000-0002-3915-4563; ORCID ID 00000-0002-7860-5339

✉ svsc071241@gmail.com

Реферат.

Мета. Метою досліджень був аналіз морфологічного різноманіття плодів окремих представників родини *Cucurbitaceae* з північних штатів Індії. **Матеріали і методи.** Зразки рослин були зібрані у різних штатах Північної Індії. Матеріали для гербарію готували за стандартною процедурою. Дослідження виконували з використанням опублікованих С. Jeffrey (1980, 1982), Н. Л. Chakravarty (1982) та S. S. Renner & A. K. Pandey (2013) контрольних списків індійських представників родини *Cucurbitaceae*.

Результати та обговорення. В Індії ряд провідних та менш поширених гарбузових культур вирощуються в декількох комерційних системах землеробства, а також як популярні городні рослини. На гарбузові припадає близько 5,6% від загального обсягу виробництва овочів у цій країні. **Висновки.** Плоди вивчених гарбузових зі штатів Північної Індії характеризуються великим різноманіттям за формою, розмірами, кольором шкірки та м'якоті, а також за різними способами використання як у харчових, так і в лікувальних цілях.

Ключові слова: гарбузина, кавун, диня, бенінказа, китайський гіркий гарбуз, трихозант зміноподібний, гарбуз.

Introduction. The family *Cucurbitaceae*, the gourd family consists of about 965 species in around 95 genera are commonly called as cucurbits (Christenhusz & Byng, 2016). Cucurbits are grown around the tropics and in temperate areas, among the earliest cultivated plants in both the Old and New Worlds for their edible fruits as vegetables (Whitaker & Davis, 1962). Some of them have medicinal importance due to the presence of secondary metabolite cucurbitacin. Checklists of the *Cucurbitaceae* of India were published by C. Jeffrey (1980, 1982) and H. L. Chakravarty (1982). A checklist of *Cucurbitaceae* of India that treats just over 400 relevant taxon names has been published by Renner and Pandey (2013). They have given the accepted names, synonyms, geographic distribution, and information on images and DNA sequences have also been provided. According to them there are 94 species (10 of them endemic) in 31 genera with their geographic distribution inside and outside India. Out of 94 species, 79% have DNA sequences in GenBank, albeit rarely from Indian material. The most species rich genera are *Trichosanthes* with 22 species, *Cucumis* with 11 (all but two wild), *Momordica* with 8, and *Zehneria* with 5. Phytogeographically, the north eastern and peninsular regions are richest in species, while the Jammu Kashmir and Himachal regions have few *Cucurbitaceae*. Morphological diversity of fruits in some members of the family *Cucurbitaceae* grown in Northern India has been described in the present communication.

Materials and Methodology. Plant specimen and their germplasm were collected from various states of Northern India. Periodical visits were made for three years (2002, 2003 & 2004). Herbarium specimens were prepared by standard procedure. Ripe fruits were collected and their seeds were extracted, dried in shade and packed in serially polythene pouches. The collected seeds and one set of herbarium of each specimen were deposited at the Museum, Department of Botany, School of Life Sciences, Dr. B. R. Ambedkar University, Agra.

Results. The list of various cucurbits collected from different parts of Northern states of India is described along with the fruit morphology in the following paragraphs:

1. *Benincasa hispida* (Thunb.) Cogn.—Ash or wax gourd is an important crop of *Cucurbitaceae* family and is known by several names such as winter gourd, winter melon, white gourd, Chinese preserving melon and pith gourd. It is cultivated in various countries of eastern and southern Asia including India. In India, ash gourd is

cultivated on an area of 2,497 ha with an annual production of 15,326 tones having average productivity 6.13 t/ha (Sidhu, 1998). Fruits are green, with round; pumpkin like to cylindrical shapes and the flesh is white. The young fruits are hairy and mature fruits are covered with a waxy cuticle (Fig. 1. A). Both the immature and mature fruits are used for culinary purposes. The fully ripened fruits are sliced or cut into chunks, boiled and candied in sugar syrup for making a special sweet. Agra is famous for making wide varieties of sweets from the fruits (Singh et al., 2014).

2. *Benincasa fistulosa* (Stocks) H.Schaefer. & S.S.Renner—Has five synonyms: *Citrullus fistulosus* Stocks; *Citrullus lanatus* var. *fistulosus* (Stocks) Babu; *Citrullus vulgaris* var. *fistulosus* (Stocks) J.L.Stewart; *Colocynthis citrullus* var. *fistulosus* (Stocks) Chakrav. and *Praecitrullus fistulosus* (Stocks) Pangalo (Renner & Pandey, 2013; Schaefer & Renner, 2011). It is commonly called as Indian round gourd or apple gourd or Indian Baby Pumpkin (Fig. 1. B).

3. *Citrullus vulgaris* Schrad.—This is a synonym of *Citrullus lanatus* (Thunb.) Matsum. & Nakai. It is commonly known as watermelon. It is a widely cultivated fruit worldwide, having more than 1000 cultivars. In India it is cultivated throughout on sandy river beds, up to an altitude of 1,500 m. It is of various shapes (round or elliptical) size (small or large) and colours (dark green, light green) with or without stripes (Fig. 1. C). The fruit wall or rind is thick and flesh is bright red and yellow flesh with several black seeds. The rind of the fruit is light to dark green and usually mottled or striped. The sweet, juicy flesh is usually deep red to pink but may be yellow also with many black seeds. Triploid seedless cultivar was developed by Japanese geneticist Hitoshi Kihara. It is a F_1 hybrid between a tetraploid watermelon, as the female parent, and a diploid watermelon, as the male parent (Kihara, 1951). The watermelon fruits are eaten raw or pickled, and the rind is edible after cooking.

4. *Citrullus colocynthis* (L.) Schrad. (Syn. *Citrullus colocynthoides* Pangalo).—It was earlier known as *Colocynthis citrullus* (Renner et al., 2017). It is commonly known as colocynth, bitter cucumber and desert gourd. Fruits of 6.5 ± 1.25 cm in diameter are green and bitter but on maturity turn yellow with white stripes (Fig. 1. E). It resembles a common watermelon vine, but bears small, hard fruits with a bitter pulp. It is widely used in numerous traditional medicines for centuries. Collected from alkaline soil (Usar land) of some districts in the state of Uttar Pradesh.

5. *Coccinia* Wight & Arn.—Has three synonyms: *Cephalandra* Schrad. ex Eckl. & Zeyh., *Physedra* Hook.f., and *Staphylosyce* Hook.f. The genus *Coccinia* has 25 dioecious species of perennial climbing or creeping herbs. *C. grandis* is the common species known as "red" or "scarlet" gourd due to the red colour of its flesh. The fruits are short and elongated with light green striped rind (Fig. 2. D). It is cultivated for vegetable purposes and also as medicine for diabetes (Holstein, 2015).

6. *Cucumis melo* L.—Commonly known as muskmelon. Fruits are pepo. Fresh ripe fruits of various shapes (round or oval) are eaten in summers (Mondal et al., 2020). Mostly cultivated in river beds and has many cultivated varieties. These include smooth-skinned varieties such as honeydew, Crenshaw, and casaba, and different netted cultivars (cantaloupe (Fig. 2. I, J), Persian melon, and Santa Claus or Christmas melon).

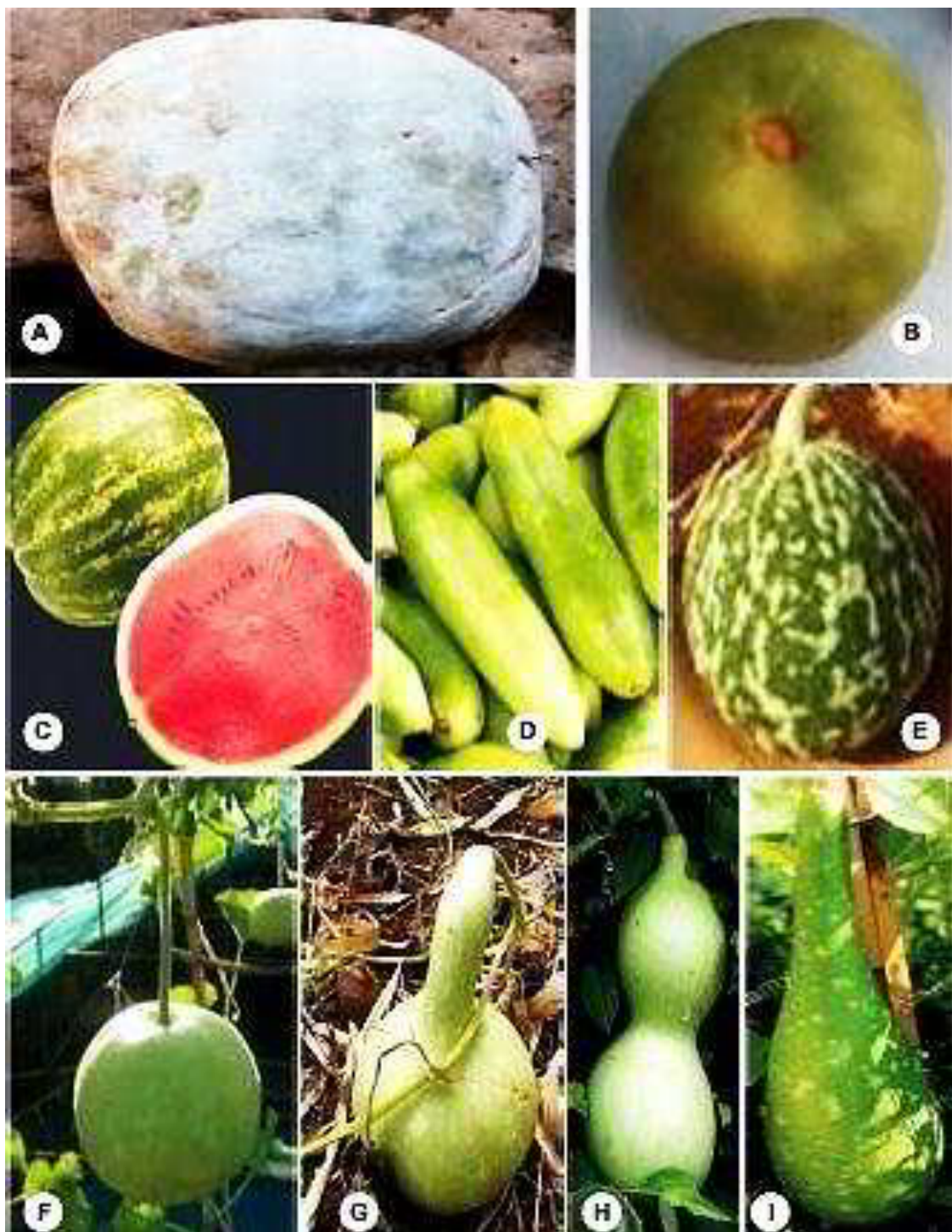


Figure 1. A.—*Benincasa hispida*; B.—*Benincasa fistulosa*; C.—*Citrullus vulgaris*; D.—*Coccinia*; E.—*Citrullus colocynthis*; F–I.—Fruits of *Lagenaria* of different shapes (F.—Round, G.—Bottle shape, H.—Double round, I.—Bean shape).

In parts it is cultivated for its smooth, yellow or brown coloured and thin skinned fruits. The pulp of cream or light pink colour is very sweet. Another special variety called sharda has round fruits with thin and smooth or netted thick skin. The

sweet flesh is of cream or light pink colour. Following are some of the varieties of *Cucumis melo* of different shape, size and colour:

a. *Cucumis melo* L. var. *momordica* Roxb.—Indian snapmelon. The availability of rich diversity in Indian snapmelon accessions indicates that India is a Centre of diversity of this variety (Dhillon et al., 2007). Both unripe and ripe fruits are edible. The fruits are tapering, elliptical pyriform, elongated, oblong or cylindrical. Skin is smooth, netted or rough and of different colour (white, creamish, yellow, light green, orange, red, pink or brown). Grown in during rainy season in the fields of crops e.g. millets and maize (Singh et al., 2015);

b. *Cucumis melo* L. var. *utilissimus* Duth. & Fuller. (Syn. *Cucumis utilissimus* Roxb.)—It is commonly called American cucumber, Snake gourd or snake cucumber. The fruit shape and size is quite variable, usually elongated and twisted and green in colour with light green stripes (Fig. 2. G). Eaten raw or part of salad and mixed with curd;

c. *Cucumis melo* L. var. *pubescens* (Willd.) Kurz.—Fruits are of various colour, shape and size with different flesh colour and rind colour. The veins of this species grow between rainy season crops. Unripe fruits are egg shaped, green and spotted with dark green colour strips (Fig. 2. K). Ripe fruits turn pink with sweet fragrance. The fruits may be round and mature fruits acquire yellow colour. Study made by Shyam Vir Singh Chauhan (1970) on four local varieties indicated that fruit shape and rind colour is controlled by independent, pair of single genes;

7. *Cucumis sativus* L.—Commonly called cucumber. It is a widely-cultivated creeping vine with edible fruits as part of salad. Origin of cucumber is from South Asia, but now grows on most continents. There are over hundreds varieties of cucumber on the World. Usually the fruit is dark green (Fig. 2. L) but creamish white variety is also found.

8. *Cucurbita* Tourn. ex L.—There are five domesticated species of *Cucurbita* are grown worldwide for their edible fruit, variously known as squash, pumpkin, or gourd depending on species, variety, and local parlance and for their seeds. There are *Cucurbita argyrosperma*, *C. ficifolia*, *C. maxima* (giant pumpkins), *C. moschata* (butternut squash), *C. pepo* (spaghetti squashes), and *C. delicata* (Ferriol & Picó, 2008; Mabberley, 2017). The fruits show a wide range of sizes, shapes, and colours; the rinds are relatively harder and the full-grown fruits can be stored for months. Fruits of *Cucurbita* are large and fleshy Fruit shape, size, colour and weight vary considerably (Fig. 3. A). The fruit weight of pumpkin is well over 300 kg and maximum is 1,190.5 kg (Giant pumpkin, 2020). The seeds are attached to the ovary wall (parietal placentation) are large and fairly flat. Following are commonly cultivated species of the genus *Cucurbita*:

a. *C. maxima* Duch.—Winter squash or pumpkin is collected from several states of India. Fruits are large with dark green skin with yellow patches and yellow-orange flesh (Fig. 3. B). Seeds flat, large yellow coloured;

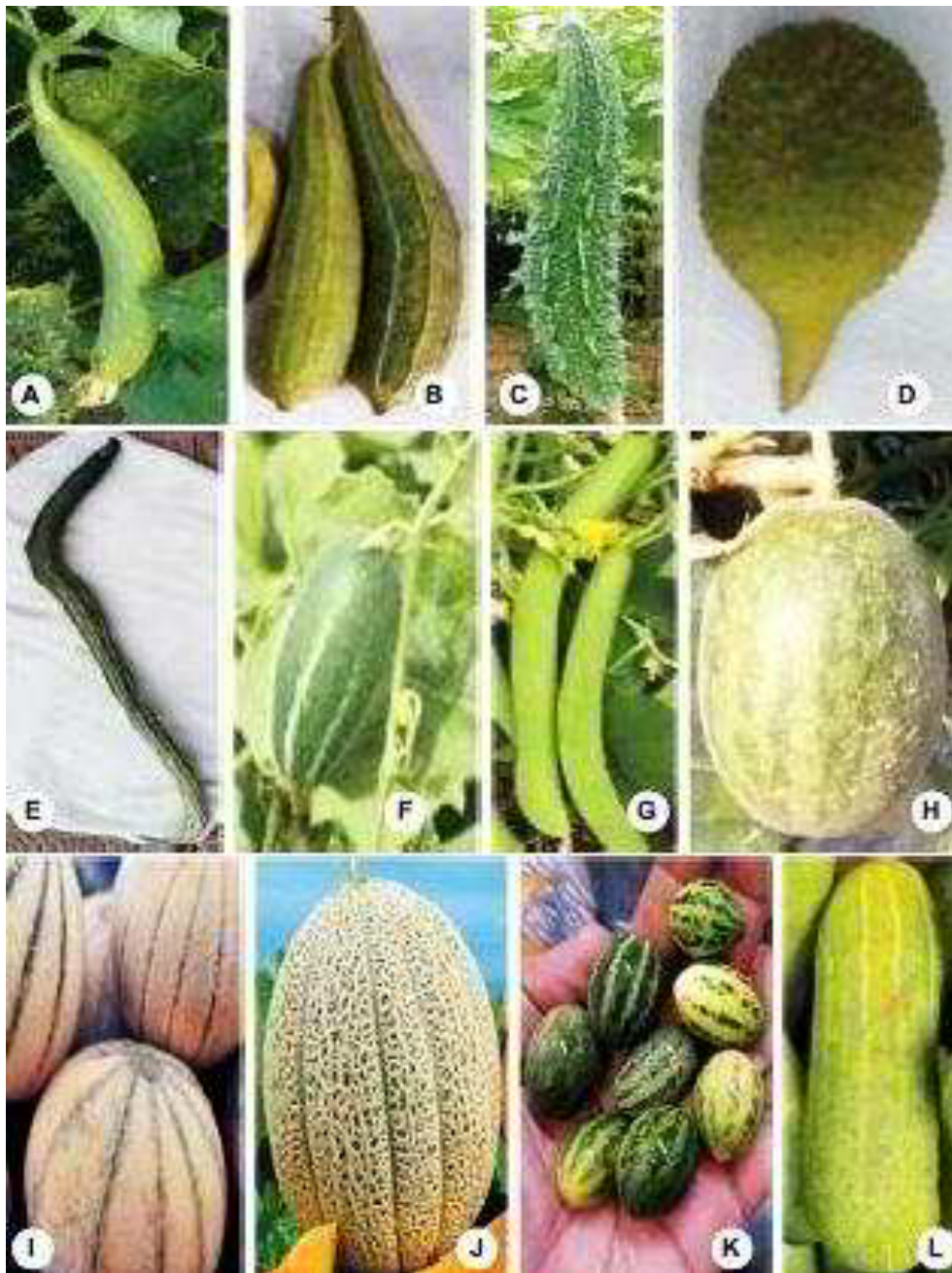


Figure 2. A.—*L. echinata*; B.—*L. acutangula*; C.—*Momordica charantia*; D.—*Momordica dioica*, E.—*Trichosanthes cucuerina*; F.—*Trichosanthes dioica*; G. *cucumis melo* var. *utilicimus*; H.—*C. melo mimordica*; I.—*C. melo* (muskmelon); J.—*C. melo* (sharda); K.—*C. melo* var. *pubescence*; L.—*Cucumis sativus* (cucumber).

b. *C. moschata* L.— Butternut squash or winter squash and grows on a vine. The fruits are sweet similar to that of a pumpkin. The skin is tan-yellow and orange fleshy pulp, but ripe fruits turn deep orange and much sweeter (Fig. 3. C, D);

c. *C. pepo* L.—It is called field pumpkin or summer squash. It has been domesticated in the New World for thousands of years (Nee, 1990). The

morphological differences within the species *C. pepo* are so vast, its various subspecies and cultivars have been misidentified as totally separate species *C. pepo* var. *cylindrica* (Paris 1986). It is the most common variety of *C. pepo*. Unlike other species and varieties of the genus *Cucurbita* it is a semi-shrub with cylindrical dark green fruits (Fig. 3. E). The fruits are cooked as vegetable in several parts of India.

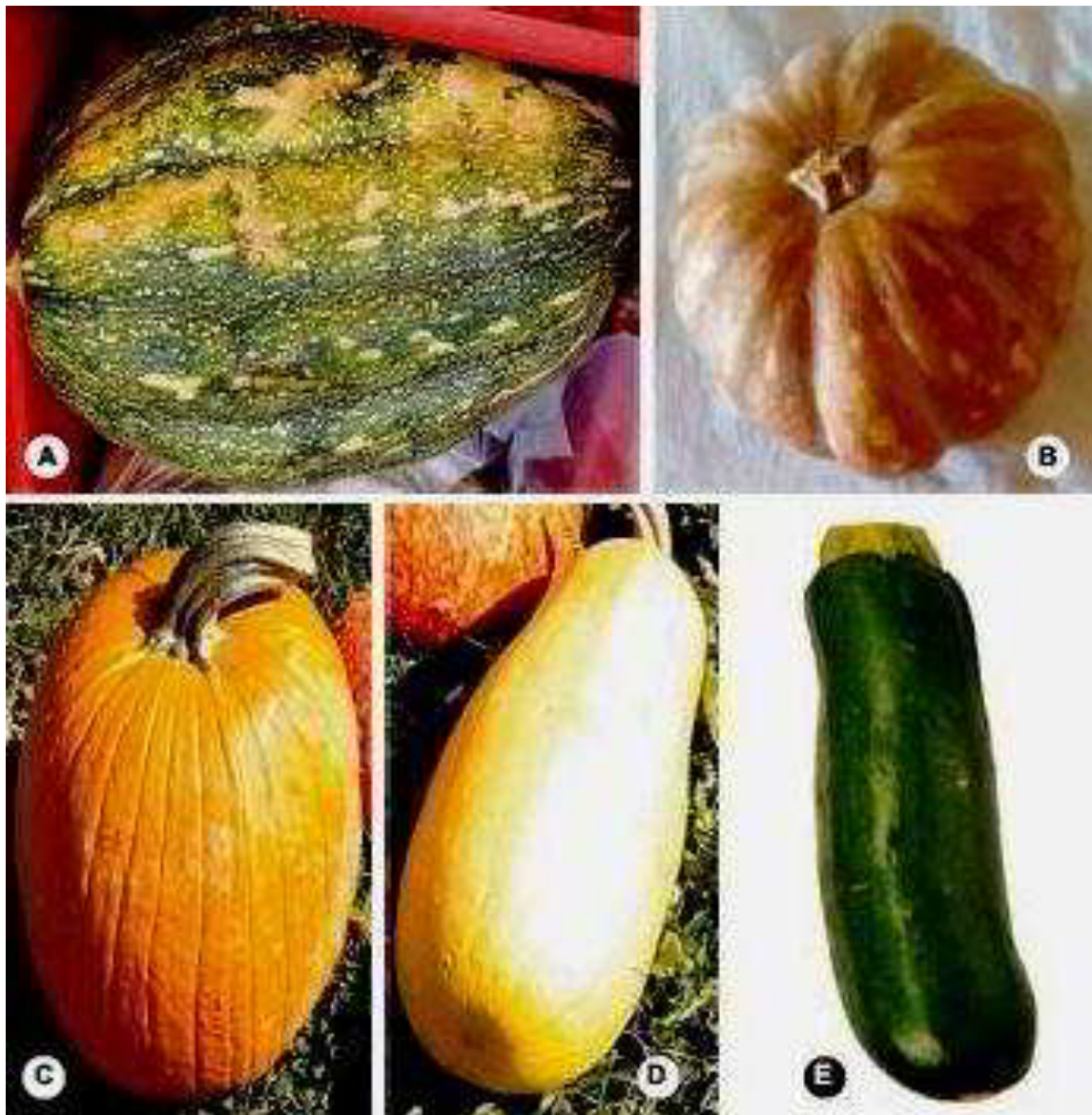


Figure 3. A & B.—*Cucurbita maxima*, C.—*Cucurbita pepo*; D.—*C. pepo* var. *recticollis*; E.—*C. pepo* var. *cylindrica*.

9. *Lagenaria sicerata* L.—Commonly known as bottle gourd. *Lagenaria* contains six species, all of which are indigenous to tropical Africa (Teppner, 2004). The best-known species, the calabash or bottle gourd, *L. siceraria*, has been domesticated by humans in large part of the world. Bottle gourd varieties are primarily identified based on fruit shape. Thomas Wallace Whitaker and Glen

Norton Davis (1962) recognized 15 common fruit shapes. Fruit shape and size in bottle gourd is the most variable among cucurbits. The fruits and seeds of white or bottle gourd (*L. sicerata*) exhibit great diversity.

On the basis of fruit shape they are called by following names:

- a. **Goal bottle gourd:** Fruits are spherical or globular with smooth and soft surface. The unripe seeds are white but turn light brown on maturity. Used as bottle by villagers (Fig. 1. F);
- b. **Chakti or flat bottle gourd:** Fruits are green spherical, surface smooth and thin with soft pericarp. Seeds light brown.
- c. **Tuma bottle gourd:** Fruits large, pyriform and look like tuma called tumari used as water bottle (Fig. 1. I);
- d. **Long of cylindrical bottle gourd:** The fruits are elongated, 30-100 cm long. Surface is green, smooth and thin (Fig. 1. G, H);
- e. **Bean or trumpet bottle gourd:** Fruits bean shaped and ripe fruits used for making a musical instrument by snake-charmers (Fig.1 I);
- f. **Kamandal bottle gourd:** Fruits are pyriform, pericarp rough and hard (1–2 cm thick). It is cultivated by Sadhus (Hermits or Saints) near their huts. Kamandals are made from ripe fruits for water storage by Saints.

10. Luffa Mill. It is comprised of seven species, four well-differentiated species from the Old World (*L. acutangula* (L.) Roxb., *L. aegyptiaca* Mill., *L. echinata* Roxb., and *L. graveolens* Roxb.) and three species from the New World. (Heiser & Schilling, 2019). *L. acutangula* is commercially grown for its unripe fruits as a vegetable. The fruit is elongated with smooth skin (Fig. 2. A) or angular (Fig. 2. B). Mature fruits are used as natural cleaning sponges (Jino et al., 2017).

11. Momordica charantia L.—Originated in India and is an annual climbing vine grown all over India. This species is commonly known as bitter gourd or bitter melon in English and karela in Hind. It has many varieties of different shape, size and bitterness of the fruits (Fig. 2. C). Cultivated all over India and used as vegetable. In Latin America and Asian countries bitter melon has been used in various herbal medicine systems since ancient times. In traditional medicine of India, different parts of the plant are still used today as claimed treatments for diabetes (Grover & Yadav, 2004; Jia et al., 2017).

12. Momordica dioica Roxb. ex Willd.—Its native range is Indian Subcontinent to Myanmar. Its cultivation up to an altitude of 1500 meters in Assam and Garo hills of Meghalaya is reported. It is commonly known as kakrol, spiny gourd or teasle gourd (Fig. 2. D). It is used as a vegetable in all regions of India and some parts in South Asia. The fruits are cooked as vegetable. It is propagated by underground tubers. It has small leaves, small yellow flowers, it has small, dark green, round or

oval fruits. It is dioecious, with distinct male and female plants. It is used as traditional herbal remedies for diabetes mellitus (Sharma & Singh, 2014; Talukdar & Hossain, 2014). It is grown with other rainy season crops (millets and sugar cane).

13. *Trichosanthes dioica* Roxb. It commonly known commonly known as pointed gourd (english), putulika (sanskrit), parval (hindi) and potol (bengali). It is perennial and separate male and female plants (dioecious). It is widely cultivated in the eastern and some northern parts of India, particularly in North eastern Andhra, Odisha, Bengal, Assam, Bihar, and Uttar Pradesh. The fruits are green with dark green or no stripes. Size can vary from small and round to thick and 20±5 cm long (Fig. 2. F). It thrives well under a hot to moderately warm and humid climate (Khandaker et al., 2018).

14. *Trichosanthes cucumerina* L. Syn. *Anguina cucumerina* (L.) Kuntze. It is a tropical or subtropical cucurbit. Variety *T. cucumerina* var. *anguina*, is commonly called as snake gourd, serpent gourd or chichinda. It is cultivated for its strikingly soft-skinned white or dark green immature fruits with stripes are 130±20 cm long. The immature fruits are eaten as vegetable (Fig. 2. E).

Discussion. There is tremendous morphological diversity within the family and the fruits of the members of the family *Cucurbitaceae* exhibit various shape, size, colour of rind and flesh and taste. The fruits are indehiscent fleshy, one-celled, many-seeded berry called pepo. Fruit develop from a single trilocular ovary divided into several carpels and parietal placentation. There are large number of seeds attached to the ovary wall are large and fairly flat. However, in water melon (*Citrullus vulgaris*), the seeds are scattered all over in the flesh.

The plants in this family are grown around the tropics and in temperate areas, where those with edible fruits were among the earliest cultivated plants in both the Old and New Worlds. In the state of Uttar Pradesh, cucurbit crops are very important for small land holding farmers and this is the cash crop for several rural families. In India, a number of major and minor cucurbits are cultivated in several commercial cropping systems and also as popular kitchen garden crops. Cucurbits share about 5.6 % of the total vegetable production of India. In India the cultivation is more common under river bed conditions to catch early market and fetches more profit. The fields during summers are not used for cultivation of crops are also utilized for the cultivation of various cucurbits for profit to poor farmers. K. P. Singh and S. V.S. Chauhan (2003) described diversity in fruits of watermelon from districts of Agra and Kanpur regions of Uttar Pradesh. K. P. Singh et al. (2003) have observed diversity of fruits in bottle gourd collected from Mainpuri district of Uttar Pradesh (U.P.). Diversity in fruit characters in some cucurbits of Agra and Kanpur districts of U.P. have been described earlier (Chauhan 2005). The fruits of cucurbits are consumed in many ways as some of them are eaten raw for their sweet and tasty flesh. The fruits are cooked as vegetables in the form of variable kinds of dishes and some the cucurbits are of high medicinal value for the cure of several ailments, particularly diabetes.

Conclusions. The fruits of studied cucurbits (family—*Cucurbitaceae*) from Northern States of India exhibit great deal of diversity in shape, size, colour of the

rind and flesh as well as many consumption ways for both food and medicinal purposes.

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