

Origin, distribution, taxonomy, genetic diversity and genetic improvement of ash gourd {*Benincasa hispida* (Thunb.) Cogn.}

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Abstract

Ash gourd or wax gourd (*Benincasa hispida*), a member of the Cucurbitaceae family, is cultivated throughout tropical and subtropical regions of the world. Fruits may be consumed immature (usually cooked or pickled) or mature (used in soups), and can also be used in confectionary. Apart from its nutritional value, wax gourd has also long been valued in Ayurvedic medicine. Current breeding efforts in wax gourd are focused on assessing available genetic diversity and the potential for heterosis. Research advances, including origin and geographic distribution, taxonomy, botanical description, genetic diversity, genetic resources, genetic improvement (cultivar groups, uses, breeding, and cultivars/varieties/hybrids), nutritional value of fruit, health benefits of fruit, ash gourd juice, ethnic/cultural significance regarding ash gourd are reviewed in this article. This review article provides a reference for basic and applied research on ash gourd, an important Cucurbitaceous vegetable crop.

Keywords: Ash gourd, Origin, Germplasm, Genetic improvement, Genetic diversity, Varieties

Introduction

Ash gourd or wax gourd [*Benincasa hispida* (Thunb.) Cogn.] is also known by several other Names such as white pumpkin, and white gourd. Mature fruits have a thick waxy cuticle. It is an important vegetable in India, China, Bangladesh, Philippines, Vietnam, Thailand, Indonesia, Turkey and Iraq. Immature and mature fruit are edible (Marr et al. 2007). The fruit flesh is white to pale-green with a weak flavor. In China and Southeast Asia, thick pieces of the mature fruit are prepared in soup, and in India fruit pieces are cooked in curries. Big fruit pieces are “candied” in India, China and Cuba. In China, a canned beverage is prepared from the fruit.

Immature fruit (“Hairy melon”) is sliced and eaten raw or cooked (Walters and Decker-Walters 1989). Young leaves, vine tips and flower buds are also consumed as boiled greens.

Benincasa hispida ($2n = 24$) annual, monoecious vines, grown for their edible fruits (Schaefer and Renner 2010; Schaffer and Paris 2016) that are particularly important to smallholder farmers, especially in Southeast Asia (Dhillon et al. 2016), where they represent an important source of calcium, iron and vitamins A and C (Pandit and Acharya 2008). It is preferred among the growers and consumers because of long shelf life under ambient conditions, good portability and appreciably good nutritive value. Ash gourd has wide use in confectionary and Ayurvedic medicinal preparations.

This fruit is called as winter melon because, when it is ripe, there is a layer of white powder coating on its skin, which looks like winter frost. And that is why the reason it is called as winter gourd, as well as white gourd. In addition, the mature melon generates a waxy covering layer, which can protect and keep it fresh as long as 12 months. Hence, it is often known as wax gourd (PHR 2021). Mature fruits are green with a characteristic waxy cuticle, but may vary in shape and size. Walters and Decker-Walters (1989) have grouped cultivars on the basis of various phenotypic traits with at least four major groups: 1) unridged winter melon group, 2) ridged winter melon group, 3) fuzzy gourd group (covered in hairs rather than waxy) and 4) wax gourd group.

Common Names

Ash gourd derives its name due to the colour of the skin of the fruit which is Ash, In some regions the skin of the Ash gourd is having a waxy shine and hence it is called, Wax Gourd. The Ash gourd can be cultivated even during rainy seasons and hence the name, winter gourd (Farm Guides 2017). The melons received their winter moniker from their extended storage capabilities.

The fruit's surface is coated in a waxy layer, allowing the melon to be harvested in the fall and stored through the winter, providing a nutritious food source during the scarce winter months. Some experts also believe the powdery, white coating on the melon's surface reminded consumers of snow, another explanation for the melon's wintery name (Speciality Produce 2018). Chi qua, hairy melon, fuzzy gourd, Chinese preserving melon, wax gourd, moa qua ("hairy gourd") is one of the staples of the Chinese diet. Chi quas are distinguished by their coating of fine hairs. The gourds need to be handled carefully, as the hairs can cause skin irritations. Chi quas are produced on a vine which can be trained over a trellis or simply sprawl on the ground. They need warm temperatures to be productive so can be produced in temperate areas during summer but more tropical areas throughout the year (NSW 2021). The Chinese winter melon, or winter melon wax gourd, is primarily Asian vegetable known by a plethora of other names including: white gourd, white pumpkin, tallow gourd, ash gourd, gourd melon, Chinese watermelon, Chinese preserving melon, doan gwa, dong gwa, lauki, petha, safed kaddu, togan, and fak. Literally, there is a different name for this vegetable for each culture that grows and harvests Chinese winter melon (Amy Grant 2021).

The common name of ash gourd in Indian languages are as follows (Farm Guides 2017, Moolihai 2020, Madhavi 2021, Sadhguru 2021): Sanskrit: Kushmanda, brihatphala, ghrinavasa, gramyakarkati, karkaru; Neer Pusanikai (Tamil); Boodidha gummadi kaaya (Telugu); Budu gumbala (Kannada); Kumbalanga/Elavan (Malayalam); Kushmanda (Sanskrit); Petha, petha kaddu, Safed kaddu (Hindi); Kumra, Chal Kumro (Bengali); Komora (Assamese); Torobot (Manipuri); Petha (Gujrathi); Petha (Punjabi); Kohla (Marathi)'.

Uses

The ash gourd fruit juice is used in Ayurvedic medicine for treating a range of ailments including insanity and epilepsy (Ramesh et al. 1989). A special type of popular ingredient of vegetable dish commonly known as "*Bori*", is also made by flesh of ripened ash gourd mixed with black gram powder. Ash gourd is one of the most common summer vegetable grown in India (Dewan et al. 2013). It is also used widely in food preparations due to its delicacy and aroma and soft nature in India, China, Taiwan, and Philippines and during festival times as a ritual food. Sweets made out of the ash gourd are famous in North India, called '*Petha*'. In south it is used in every house hold in daily preparations of Sambhar, Koottu, Salads and Juice (Farm Guides 2017).

Ash gourds are not typically consumed raw and contain

a mild, vegetal, and subtly grassy flavor reminiscent of a watermelon rind or cucumber. When cooked, the flesh becomes transparent and softens, absorbing accompanying flavors. In the present-day, ash gourds are often sold pre-sliced in local markets due to their large size. Though they are botanically a fruit, ash gourds are cooked and consumed similarly to vegetables and are prevalently seen in soups, curries, and stir-fries in Indian and Chinese cuisine. Ash gourds have neutral flesh that readily absorbs accompanying flavors, best suited for cooked applications such as steaming, stir-frying, simmering, and braising. The skin is inedible and is typically discarded, but sometimes the melons are hollowed and used as a decorative serving bowl. The seeds are also removed from the flesh before cooking, but they are edible once cooked and can be roasted or fried as a crunchy snack. Once trimmed and deseeded, ash gourds can be sliced or cubed into smaller pieces and are commonly incorporated into soups, curries, and stews. The flesh is also stir-fried with robust spices and herbs, or it is stuffed with meat and cooked, mixed into casseroles, used as a substitute for zucchini, or quick-pickled for a tangy flavor. In addition to savory dishes, Winter melons are blended into smoothies or juices and are combined with sweet fruits, lemon, salt, and pepper, or the flesh is simmered with sugar to create a syrup that is popularly incorporated into tea. Winter melons are also used as a filling in cakes, pastries, and pies, or they are cooked into candy. Ash gourd pairs well with watermelon, savory meats such as pork, chicken, duck, and ham, seafood, including shrimp and scallops, mushrooms, scallions, ginger, bamboo shoots, peas, and lentils. Whole ash gourds will keep for 3 to 5 months when stored in a cool, dark place away from direct sunlight. Once sliced, the ash gourd pieces will keep up to one week when stored in a plastic bag in the refrigerator's crisper drawer. Peeled and raw ash gourd chunks can also be frozen for extended use. The flesh is candied and stuffed into dessert pastries, stewed into hearty winter soups, stir fried and used to fill moon cakes for China's Autumn Moon Festival (Speciality Produce 2018).

The ash gourd can be stored for many months. Ash gourds of the Indian subcontinent have a white coating with a rough texture (hence the name ash gourd). Southeast Asian varieties have a smooth waxy texture. It is one of the few vegetables available during winter in areas of deciduous vegetation. In India, the ash gourd is recognized for its medicinal properties in the Ayurvedic system of medicine. It also has significance in spiritual traditions of India and Yoga, where it is identified as a great source of *prana*. In Chinese cuisine, the gourds are used in stir fries or

combined with pork or pork/beef bones to make winter gourd soup, often served in the scooped out gourd, carved by scraping off the waxy coating. It is also chopped and candied. In Indian cuisine it is traditionally used to prepare a wide variety of dishes. In northern India it is used to prepare a candy called *petha*. In South Indian cuisine, it is traditionally used to make a variety of curries, including a stew made with a yogurt base. The juice of the raw ash gourd (*Maipawl* or *Khar*) is used by the Mizo community and indigenous Assamese ethnicities of North-East India as a natural remedy to treat mild to severe dysentery. In north India, particularly in the middle Himalayas, it is paired with pulses such as moong which, when crushed, along with ash gourd, make a dish locally called *bori*. When dried in sunlight it becomes somewhat hard and is used in curry dishes and eaten with rice or chapati. This practice is especially prevalent in the Himalayas due to the long shelf life of the resulting product. In Andhra Pradesh, it is called *Boodidi Gummadi kaya* (Telugu). It is used to make stews, stir fries and *vadialu*. *Vadialu* (plural; *vadium* is singular) are made by chopping the ash gourd in to small pieces and mixing with yogurt and spices, then sun-drying. To eat, *vadialu* are deep fried in oil and eaten as an accompaniment to rice and *sambar* or lentil stews. In Kerala, the plant is called *Kumbalam* and the fruit is called *Kumbalanga* or *Kooshmandam*. It is traditionally used to offer ‘*Guruthi*’ instead of ‘*Kuruti*’ among Malayali Brahmins. Thus, instead of offering someone’s life in the pyre, an ash gourd is cut into two as a symbolic performance in lieu of human sacrifice. In Udupi cuisine, the ash gourd is known as *Budu Kumbda* or *Boldu Kumbda* in the Tulu language, *Budi Kumbalakayi* in Kannada is used to prepare dishes like *Kodel* (*Sambhar*), *Ale bajji*, *Kashi Halwa* and *chutney*. In Maharashtra, the ash gourd is known as *Kohalaa* in Marathi language, *Kohala* is used to prepare a sweet dish called *Kohalyachi Vadee* (*Burfi*), it is also used to preparing (*Sambar*). In Gujarat, it is called *kolu*. In Bengal, it is called “*Chalkumro*”. There are various dishes made with it, viz., *Chalkumro*’r *Bora*, *Chalkumro* ghonto, *Chalkumror* *dudh* curry, *Chalkumro* with *mung dal*.

In Nepal, where it is called *Kubhindo*, it is cooked as a vegetable when young, but the ripe gourds are usually made into preserves or crystallized candy known as “*murabba*” or “*petha*”. Occasionally, it is used to produce a fruit drink with a distinctive taste. It is usually sweetened with caramelized sugar. In Southeast Asia, the drink is marketed as wax gourd tea or wax gourd punch. The shoots, tendrils, and leaves of the plant may also be eaten as greens (WIKI 2021).

Mature fruits of ash gourd are used in making confectionery, i.e., candy, preserves, sweets and pickles and immature fruit (young) as culinary vegetable in West Bengal, Odisha, Kerala, Tamil Nadu and NEH Region of India. Generally, specific cultivars or land races are grown for vegetable preparation at immature stage and for the preparation of sweets at mature fruit stage. The ash gourd enzyme may have potential as an alternative for calf rennet in cheese manufacture (Mousumi 2021). It is popularly used in making soups and sweet dishes in China as it is one of the few vegetables, which are available in the winters. Used in many traditional Vietnamese soups and stews. In Taiwan it is used as the base filling in mooncakes for the Moon Festival. Mooncakes are an ancient Chinese preparation, which may have either a sweet or a savory taste. It is popular in many other countries as well such as Japan, Indonesia, Phillipines and even in the United States. Popularly grown in Southern India, it is used to prepare a traditional sweet called “*petha*” and is also used in making curries. Often used in India to make liquefied dishes along with dairy products. When small, the ash gourds are used as fruits to prepare certain fruit drinks as they are sweet, but once they mature they lose their sweetness and are essentially used as vegetables. Also the tender leaves and twigs of ash gourd are eaten as leafy vegetables (Anon. 2021).

Nutritional Value of Fruit

Ash gourd has nutritional values as follows according to USDA nutrient database. Each 100 g of ash gourd contains, Energy : 13 kcal, Fat: ‘0’, Carbohydrates : 3 g, Fiber content: 2.9 g, Protein : 4 g, Vitamin C: 13 mg, Riboflavin : 0.1 mg, Niacin : 0.4 mg, Folate : 5 mcg, Pantothenic Acid : 0.1 mg, Calcium : 19 mg, Iron : 4 mg, Magnesium : 10 mg, Phosphorous : 19 mg, Potassium : 6 mg, Sodium : 111 mg, Zinc : 0.6 mg and Manganese : 0.1 mg (Farm Guides 2017). Ash gourds are an excellent source of vitamin C to strengthen the immune system and fiber to stimulate and regulate the digestive tract. The fruits also provide antioxidants to protect the body against environmental aggressors, magnesium to maintain healthy nerve functioning, phosphorus and calcium to promote strong bones and teeth, and contain lower amounts of folate, zinc, and iron (Speciality Produce 2018). In Traditional Chinese Medicine, Winter melons are viewed as a cooling or an ingredient and are used to reduce inflammation and balance the body through their alkaline properties (Speciality Produce 2018). While ash gourd is composed primarily of water (about 96%), it also boasts a variety of beneficial vitamins and minerals, including vitamin C

Table 1: Nutritional value of fruit per 100 g

Nutrient	Nutritional Value
Total Fat	3.9 g
Saturated Fat	0.5 g
Total Carbohydrate	12.5 g
Dietary Fiber	0.6 g
Protein	2 g
Sodium	33 mg
Potassium	359 mg
Vitamin A	9.80 %
Vitamin B6	11.30 %
Vitamin C	30.50 %
Vitamin E	1.10 %
Calcium	5.10 %
Magnesium	6.70 %
Phosphorus	5.00 %
Zinc	7.20 %
Iron	5.70 %
Manganese	12.50 %
Iodine	5.90 %

and B-complex vitamins such as niacin, thiamine and riboflavin. Ash gourd is also a valuable source of minerals like iron, potassium, zinc, calcium and magnesium. The gourd also provides a good amount of protein, carbohydrates and dietary fiber (Table 1) (Sadhguru 2021).

Health Benefits of Fruit

It is a very good Chinese herb and has awesome medicinal value. In other words, you may not know

that you are casting away some of the best essence available in this fruit. As a matter of fact, this melon is a treasure inside out – all its constituent parts, including pruina (a white powdery bloom), peel, flesh, pulp, seed, even vine, leaf, and flower, can be used medicinally. It is juicy, big in size and low in calories so that its thick white flesh is often made into soup. Ash gourd soup during summer in order to quench thirst and induce diuresis (PHR 2021). The health benefits of ash gourd fruit are furnished in Table 2 (PM FME 2022). The fruits are useful in asthma, cough, diabetes, haemoptysis, hemorrhages from internal organs, epilepsy, fever and vitiated conditions of pitta. The seeds are useful in dry cough, fever, urethrorrhea, syphilis, hyperdipsia and vitiated conditions of pitta. It is a rejuvenative drug capable of improving intellect and physical strength. In Ayurveda, the fresh juice of the fruit is administered as a specific in haemoptysis and other haemorrhages from internal organs. The fruit is useful in insanity, epilepsy and other nervous diseases, burning sensation, diabetes, piles and dyspepsia. It is a good antidote for many kinds of vegetable, mercurial and alcoholic poisoning. It is also administered in cough, asthma or respiratory diseases, heart diseases and catarrh. Seeds are useful in expelling tapeworms and curing difficult urination and bladder stones (MP 2014). Ash gourd is referred to as *Ilavan Kumbalam*. Ash gourd was once an integral

Table 2: Health benefits of ash gourd fruit

Health benefits
• One among best food for the diabetic patients
• Low calorific value
• Intake of ash gourd regularly will help to reduce excess weight (obesity)
• Helps to keep body cool
• Reduces constipation problem
• Good detoxifying agent
• Controls high cholesterol
• Enhances memory power
• Act as a blood coagulant
• Good for cold relief
• Good for treating asthma
• Its seeds used in the treatment of intestinal worms
• Leaves are rubbed on the bruises to heal them.
• Ash gourd juice in empty stomach, good for ulcers.
• It helps in maintaining water balance, diuresis etc.
• It has anabolic activity, helps to grow new tissues, balancing acidity and alkalinity
• Problems in the stomach and intestine
• It is used as brain food to treat mental illness and nervous disorders such as epilepsy.
• Seeds are having angiogenesis properties which stops the growth of tumors and
• Progression of cancer by limiting the formation of new blood vessels. Ash from burning rind and seed when mixed with coconut oil when used promotes

part of most Malayalees' diet. Medicinal Ash Gourd – *Vaidya Kumbalanga* and *Nei Kumbalam* all are the same. Ash gourd is still highly regarded for its medicinal qualities. *Kumbalanga* is excellent for most stomach related disorders since it has a cooling effect. It is effective in regulating pH levels in the stomach which stabilizes blood pressure (major cause of other diseases). Each gourd weighs around 500 g to 1 kg, and is generally ovoid (shape of an egg). *Ney Kumbalanga* (*vaidya Kumbalanga*) is a disappearing vegetable, at least in Kerala, like few of the other vegetables (Natural farmer 2016).

While *Nei Kumbalam* has been traditionally employed by Ayurvedic healers to prepare medicine, as a vegetable, *Nei Kumabalam* is no different in texture or taste from the larger varieties of Ash gourd we see in markets today (Lumiere 2017). However Naturopaths and other healers who swear by the Ash gourd's high Pranic power and its hugely positive impact on the nervous system recommend eating it sliced raw or drinking its juice on an empty stomach to imbibe its positive energy rather than just letting it just hang outside a building (Lumiere 2017). It has medicinal properties and is used in the Ayurvedic preparation, '*Kushmanda Rasayana*' in India. According to various studies made recently, the Ash Gourd is capable of treating many health related issues. It has anticancer qualities. It is said to have properties for treating diabetes, kidney dysfunction, inflammatory conditions, nervousness and used in the treatment of digestion related conditions like ulcer, vomiting, burning sensation of chest and acidity. Its extracts are also used in treating conditions like headache and tension; acts as an antidepressant and used for conditions like seizures, cold, fever and asthmatic conditions (Farm Guides 2017).

Extract of ash gourd has acid neutralizing property and recommended in Ayurveda for management of peptic ulcer. Fruit juice is used for treating a range of ailment, including insanity epilepsy. It is important in sport medicine and used for the improvement of musculature and also used for blood sugar patient. It is also considered good for people suffering from nervousness and debility. The Chinese used this gourd for a range of medicinal purpose. In Ayurveda literature, it is mentioned that the fruits contain tonic, nutritive and medicinal properties. Genotype with high ascorbic acid is useful in cucurbits. Cucurbitacin from ash gourd had protective effect on kidney damage caused by mercuric chloride (Mousumi 2021).

Ash Gourd Juice

Ash gourd juice is a great detoxifying agent, and is best

consumed early morning. This juice can absorb all the toxins, germs and contamination that may have accumulated in our body through the course of a day. It also has the potential to flush the waste out of our system. Its components comprise calcium, iron, phosphorous as well as Vitamin C. The seed of the ash gourd vegetable, which has a pale yellow oil, must be removed before processing in the juicer. This juice is also beneficial for people suffering from constipation as it comforts the digestive belt. The mixture of the popularly known *safed petha* along with the likes of coconut milk, lime juice and amla juice is equally beneficial. In case of the presence of gastroenteric worms, a combination of coconut milk and ash gourd juice can help bring relief. It also encourages tissue growth. Ash gourd juice was also shown to reduce morphine withdrawal symptoms in rats. Hence, it was concluded that it could also possibly help patients battling opioid addiction. Ash gourd, which is easily available in the markets, could also come to the aid of those who are underweight. Its juice has the potential to boost metabolism and could be an effective cure for anorexia, an eating disorder that compels one to obsess over what they consume (Lifestyle Desk 2020). Ash gourd Juice absorbs all the toxins and flushes out the waste from our body. This is all the waste which has been accumulating over the years of eating processed food, fried food, and many other eating habits. Whenever we drink ash gourd juice it takes out few toxins while leaving the body. Drinking ash gourd juice also cools our body, will have increased energy and enhances your intellectual capabilities. It doesn't have any taste, very neutral like water. It is highly recommended to drink pure ash gourd juice for full benefit (Madhavi 2021).

Ethnic/Cultural Significance

The indigenous variety of *Nei Kumbalam* is often hung in front of a new house or at construction sites to ward off the 'evil eye' because of its immense positive energy (Lumiere 2017). In Kerala, the plant is called *Kumbalam* and the fruit is called *Kumbalanga* or *Kooshmandam*. It is traditionally used to offer '*Guruthi*' instead of '*Kuruti*' among Malayali Brahmins. Thus, instead of offering someone's life in the pyre, an ash gourd is cut into two as a symbolic performance in lieu of human sacrifice (WIKI 2021).

Origin and Geographic Distribution

The study of cucurbit domestication in recent years has benefitted from the increasing integration of archaeological and genomic data with insights from herbarium collections, the most efficient way to

understand species' natural geographic ranges and climate adaptations. Domestication involves humans acting as dispersers and modifiers of a crop's biotic and abiotic environment. It is a gradual process and often is not restricted to a single place or human population (Chomicki 2020).

Ash gourd is widely distributed throughout the tropical and subtropical Asia (Purseglove 1987). However, Yawalkar (1985) mentioned that the original home of ash gourd is believed to be Java. It is believed to have originated in India. Indo-China region being a centre of diversity is endowed with great variability in terms of morphological characters especially, growth habit, maturity including shape, size and flesh thickness of fruits. Rind and seeds of a gourd discovered at the Kana site in Papua New Guinea are identified as remains of *Benincasa hispida*; therefore, it may be possibly domesticated at the Kana site (Matthews 2003). The origins of *Benincasa hispida* remains largely undescribed, with no molecular studies to date. Today, ash gourd is cultivated mainly in Southeast Asia and Australasia (Chomicki et al. 2020), but the place of domestication is undetermined, although wild forms (long elusive) have been described from Australia, Japan and parts of Melanesia (Marr et al. 2007). Ash gourd's precise origin is unknown for a few reasons: First, it is an ancient vegetable; and secondly, ash gourd's incredible genetic diversity spans several regions. Botanists have come up with a few possible contenders including Japan, Indonesia, China, and Indo-Malaysia. Indeed, ash gourds have existed in all of these regions for thousands of years—Chinese literature praises its medicinal value in texts from 5 to 6th century AD. Wax gourd is seldom seen in Western countries, as the cooler temperatures inhibit its cultivation (Reddy 2014). Although the scientists and researchers point out that ash gourds are more likely native to Japan, China, Indonesia, or Indo-Malaysia, the plant's ancient roots make it hard to find out the precise origin. However, the countries mentioned above have been using Ash gourd for many decades (Moolihai 2020, Sadhguru 2021).

The cultivated forms may have originated in South-eastern Asia. Chinese writings of the 5th and 6th centuries A.D. mention *B. hispida*. An earlier cultivation of this species in China is suggested by a folktale that is believed to date to pre-Han times (before 206 BC- 220 AD) (Walters and Decker-Walters 1989). As the existence of wild populations is unconfirmed, the center of origin for *Benincasa hispida* is uncertain. It is possible that it is a native of Indo-Malaysia (Mini Raj et al. 1993). The Indo-China region is regarded as the center of origin, and the genus *Benincasa* is considered monotypic.

Related wild species of *Benincasa* are not known. Ash gourds are native to Asia and Southeast Asia, where they have been cultivated since ancient times. The vining plants are believed by experts to have been used in culinary and medicinal preparations in China as early as 500 CE (Common Era), and over time, the species was established as a common garden cultivar in Japan, Indonesia, and India (Speciality Produce 2018). Descriptions of the gourd's medicinal value can be found in Chinese texts from the 5th-6th century AD (Sadhguru 2021). Ash gourd is believed to have originated in Java and Japan. The diversity of cultivar in China suggested that this crop might be the indigenous to Southern China (Mousumi 2021).

Growing Areas

Though it has been cultivated in China from the ancient period, it is not clearly known from what time this crop is being cultivated in the Indian subcontinent. It is widely cultivated in India, China, Malaysia, Indonesia, Philippines, Taiwan, Bangladesh and the Caribbean Islands. Ash gourd is grown throughout the Old World tropics and less commonly in the New World. It is grown widely in the plains of India, Burma, and Sri Lanka up to an altitude of 1500 m (Mini Raj et al. 1993). A related minor crop, *Benincasa fistulosa*, is cultivated in India and Pakistan, where wild forms also exist (Renner and Pandey 2013). Today, ash gourds remain an important vegetable crop in India, Southern China, Bangladesh, and other parts of South East Asia (Reddy 2014). Ash gourd is an important crop in Vietnam, where it is cultivated on more than 33,000 ha annually (Dhillon et al. 2016). It is grown throughout old world tropics and is less common in new world tropics. In India, the crop is widely grown in UP and Delhi for preparation of 'Agra petha' and in southern states for use as vegetable (TNAU 2016).

It is widely grown throughout South and South East Asia, including Myanmar, Malaysia, China, Japan and almost all countries of South East Asia as a prominent crop. It does not grow in Western Countries, since it cannot survive the extreme cold (Farm Guides 2017). Today ash gourds are grown in warm climates worldwide and sold through local markets, specialty grocers, and Asian markets in the Americas, Australia, Asia, Africa, and Europe (Speciality Produce 2018). It is grown throughout the plains of India, Burma, and Sri Lanka up to an altitude of 1,500 m. It is mainly grown in North India, especially in Uttar Pradesh, where it is used for the preparation of candies (Mousumi 2021). Ash gourd is normally grown in South East Asia, China and India. In India, it is grown in Punjab, Uttar Pradesh,

Bihar, West Bengal, Northeastern hill states, Odisha, Kerala and Tamil Nadu on commercial scale, however, it is grown sporadically throughout India (Mousumi 2021).

Taxonomy

The Cucurbitaceae is today an economically important family, including some of the world's most important crops. The following six tribes contain species of major or minor economic importance, as defined by Chomicki et al. (2020): tribe Benincaseae, tribe Cucurbitae, tribe Joliffieae, tribe Momordiceae, tribe Sicyoeae and tribe Siraitieae. Ash gourd {*Benincasa hispida* (Thunb.) Cogn.} commonly called hairy melon, wax gourd, winter melon, ash pumpkin, or white pumpkin—is the only species in the genus *Benincasa* and it belongs to the family Cucurbitaceae (Mini Raj et al. 1993, Anon. 2021). There are many synonyms such as *Benincasa cerifera* Savi, *Benincasa cylindrica* Ser, *Benincasa hispida* var. *chieh-qua* F.C.How, *Benincasa hispida* var. *hispida*, *Benincasa pruriens* (Parkinson) W.J.de Wilde & Duyfjes, *Benincasa pruriens* f. *hispida* (Thunb.) W.J.de Wilde & Duyfjes and *Benincasa vacua* (F.Muell.) F.Muell. (Plant List 2013, MP 2014).

Botanical Description

Benincasa hispida (2n=24) is a robust, hispid, monoecious, annual vine with stout, prominently furrowed stems and bifid tendrils. Leaves, which range from 10 to 25 cm in length and 10 to 21 cm in width, are five-lobed with a cordate base. The five-parted yellow flowers, which are solitary in the leaf axils, are 6–14 cm in diameter and 3–5 cm in length, excluding the ovary. Staminate flowers have long peduncles (5–15 cm); peduncles of the carpellate flowers are much shorter (1–3.8 cm). Sepals are 5.5–20 mm in length, 3–24 mm in width, and foliaceous. Fruits, covered with white silky hairs when young, may be oblong, cylindrical, or globular. General fruit shape is evident in the immature ovary. When mature, the green rinds are speckled light green and, in some cultivars, are coated with a layer of white chalky wax and/or a dense pelt of minute hairs. The white flesh of the fruit is crisp and juicy. The numerous seeds are flat, smooth, and buff, ranging from 1 to 1.5 cm in length and 0.5 to 0.8 cm in width. The seed margins are ridged in some cultivars and smooth in others (Fig. 1) (Walters and Decker-Walters 1989, Mousumi 2021).

It is a vigorous but slow growing trailing annual. Stem and all other parts are covered with bristle-like hairs. This monoecious crop produces large male flowers with long pedicels and female flowers with densely haired

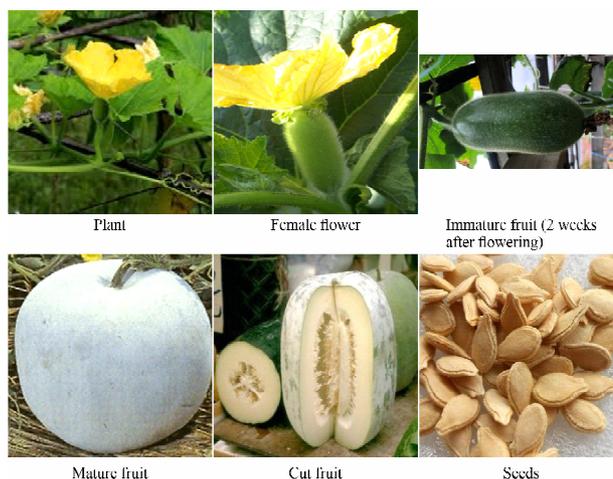


Figure 1: Different parts of ash gourd plant

ovary and short peduncle on same plant. Corolla is yellow in colour and large in size. Ratio of staminate to pistillate flowers is 34:1. Anthesis takes place at 4.30 – 7.30 a.m. and anther dehiscence is at 3.00 – 5.00 a.m. Stigma is receptive from 8 hours before to 10 hours after anthesis (TNAU 2016).

Ash gourd is a crawling or climbing vine. The vines can be several meters long. The yellow flowers are either male or female. Leaves are long (10- 20 cm) and have a long hairy stem. Ash gourds have cylindrical or oval fruits which can reach a length of 80 cm and sometimes longer. The diameter is up to 30 cm. When immature, the fruits have a thick white flesh with a sweet taste. Mature fruits are not hairy but develop a waxy coating. Mature fruits are not sweet; the whitish flesh is rather tasteless. The waxy coating provides a long shelf life; ash gourd fruits can often be kept for a year or longer. Ash gourd has separate male and female flowers on the same plant. Cross pollination is by insects. Vines can crawl or climb (e.g. in trees) and reach a length of several meters. Ash gourd is propagated by seeds. Fruits are handpicked, either green or ripe (Anon 2021).

Ash gourds are large fruits, averaging 15 to 80 cm in length, and have a bulbous, round to oblong shape with blunt, curved ends. The ash gourds are covered in a thin but tough, light to dark green skin, often enveloped in a textured, chalky layer of wax, depending on the variety. Young ash gourds also bear a pale, fuzzy coating of hair that disappears as the fruit matures. Underneath the hard surface, the flesh is thick, firm, aqueous, and white, encasing a large central cavity filled with pithy membranes and cream-colored oval seeds. The seeds are edible once cooked and have a nutty, neutral taste (Speciality Produce 2018). The plant has a musky smell. The stems are angular, 3 mm–4 mm in diameter and hispid. Leaves: simple, alternate and without stipules.

The petiole is 6 cm–8 cm × 2 mm and hispid. The blade is palmately 5-lobed, very thin, and hispid underneath. The blade is serrate, and shows 5–6 pairs of secondary nerves. The flowers are simple, axillary and showy. The flower pedicels are 5 cm–10 cm long and hispid. The calyx consists of 5 linear, 8 mm long hispid sepals. The corolla consists of 5 yellow, orbicular, very thin and showily nerved petals. The fruits are massive, 40 cm long, ovate berries covered with a dense chalky white powder (MP 2014).

The fruit is covered in a fuzzy coating of fine hairs when young. The immature melon has thick white flesh that tastes sweet. By maturity, the fruit loses its hairs and develops a waxy coating, giving rise to the name wax gourd. The wax coating helps to give the fruit a long shelf life. The melon may grow as large as 80 cm in length (WIKI 2021). Seeds are numerous, about 1 cm long and about 6 mm wide. Skin is yellowish white, sometimes with cracks, one circular end, and one pointed end, which has 2 small projections and the smaller one is the hilum. After stripping the seed coat, the milky, oily kernel thus shows. The seeds have slight odor and slightly sweet taste. Flower season is from May to June and fruit season is from June to August (PHR 2021).

Golden yellow flowers form in the leaf axils in early summer. Female flowers are followed by oblong to nearly spherical melon-like fruits which vary in appearance and uses depending on growth stage. Young fruits are often commonly called fuzzy gourd (particularly *B. hispida* var. *chieh-qua*) because they are covered with a soft down which eventually disappears as the fruits mature. White flesh is crisp and juicy. Young fruits are perishable (should be eaten within a week of being picked) and are typically used somewhat the same way as summer squash. They may be peeled, shredded or cut into chunks for baking, sauteeing or adding to soups. Mature fruits are commonly called winter melons because of the waxy coating which protects the fruit and allows for long-term storage. Winter melons typically range in size from 5-20 pounds in rounded shapes (to 12" diameter) or in cylindrical shapes (to 15" long), but in ideal conditions may grow much larger (to 25-50 pounds and to 4-6' long) (MBG 2021). Mature fruits are green with a characteristic waxy cuticle, but may vary in shape and size. Some authors have grouped cultivars on the basis of various phenotypic traits with at least four major groups: unridged winter melons, ridged winter melons, fuzzy gourds (covered in hairs rather than waxy) and wax gourds. Many landraces also remain popular in different parts of Asia, and the crop remains relatively underdeveloped commercially (Resmi 2004).

Genetic Diversity

India and China hold maximum diversity in terms of fruits (Fig.2) with fruit weight ranging from 1.5 to 50 kg, and various shapes such as round, oval, oblong, long cylindrical, and short cylindrical. Fruit skin color varies from light-green to dark-green, and speckled green. Fruits may carry strong, medium, or weak wax, or be wax-less. There are five categories of seed size; super small seed (90-95 seeds/g,) very small seed (60-65 seeds/g), small seed (35-40 seeds/g), medium seed (20-25 seeds/g), and large seed (10-12 seeds/g) (Dhillon et al. 2016). Round or oblong fruits (6-8 kg) of light-green to dark-green color are preferred by Indian consumers, whereas long cylindrical fruits (1-2 kg) with dark-green color and white specks are preferred by consumers in Vietnam. Variability in ash gourd is limited except for size and shape of fruits. In Northeast India, landraces are genetically divergent from those originating from other parts of the country (Fig. 3) (Pandey et al. 2008).

An experiment was conducted to study the field performance, variability and genetic divergence for yield and yield contributing characters of 46 ash gourd genotypes at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh. Wide range of

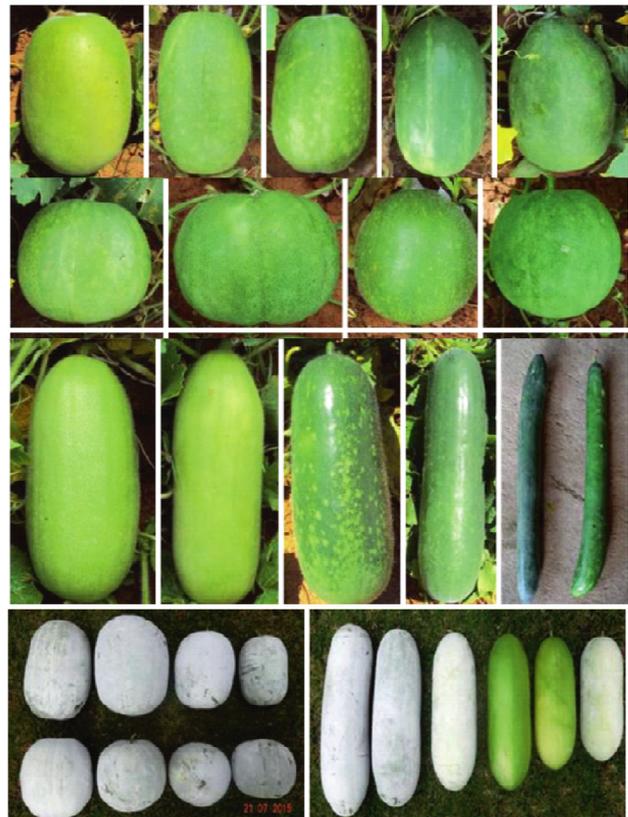


Figure 2: Variation for fruits among in ash gourd varieties

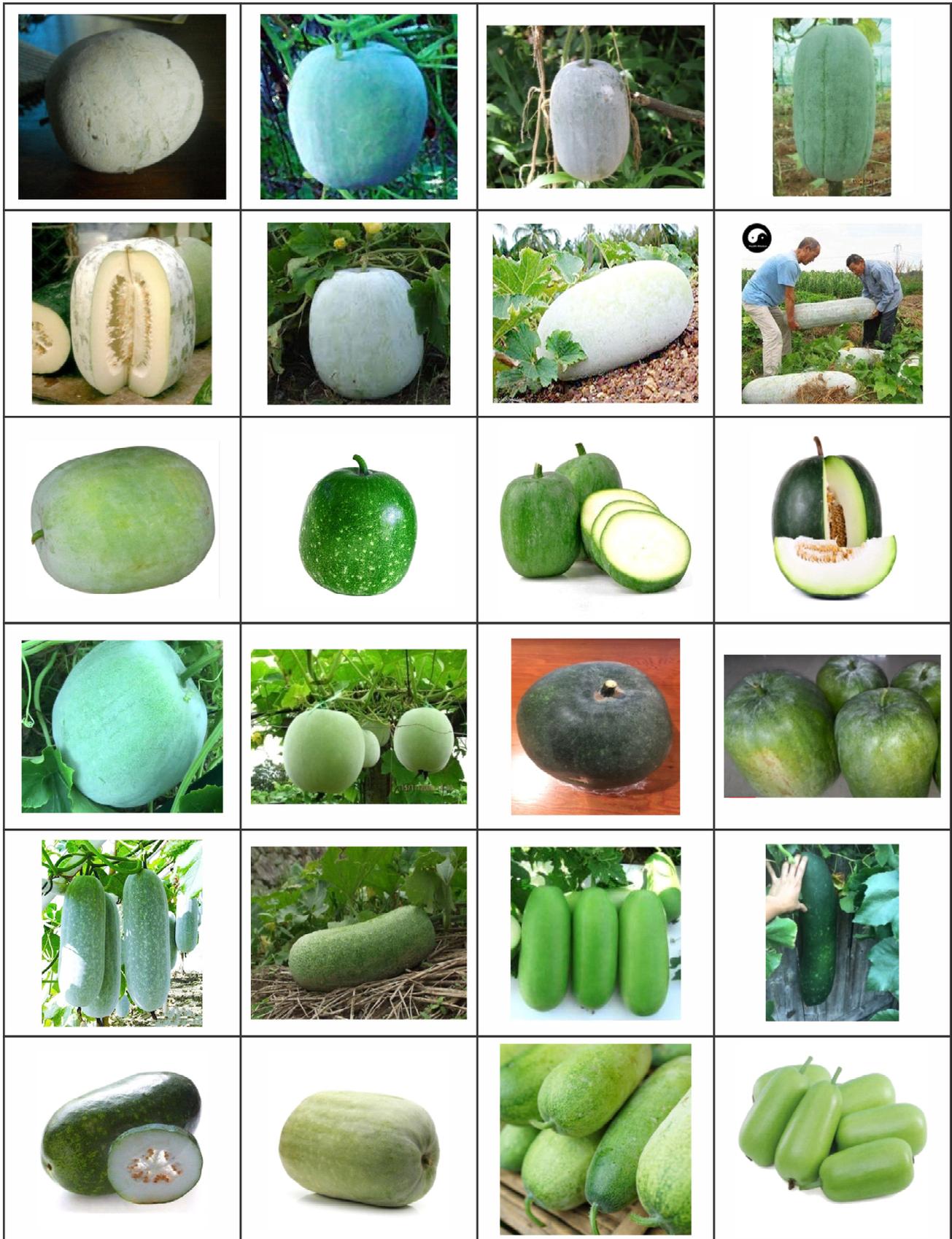


Figure 3: Variability for fruit color, size and shape in ash gourd

variations were found among the ash gourd genotypes in respect of different parameters such as vine length at harvest, fruit length, fruit diameter, sex ratio, number of fruits plant/plant, average weight of fruit and yield plant/plant. The genotype BH21 showed the highest performance in number of fruits/ plant and yield /plant. In respect of average weight of fruit, the genotype BH16 produced the heaviest (1.86 kg) fruit and the genotype BH17 produced the lightest (0.67 kg) fruit. The genotype BH18 had the highest sex ratio (8.16) and the genotype BH14 had the lowest sex ratio (3.44). In case of number of fruits plant-1, the genotype BH46 and BH53 had the minimum number of fruits (1.33) and the genotype BH21 had the maximum number of fruits (16.16) per plant which was statistically similar with the genotype BH12 (15.00). The genotypes were also tested for genetic divergence utilizing the multivariate analysis. The genotypes were grouped into eight clusters. However, there was no relationship found between genetic divergence and geographic distribution of the genotypes (Dewan et al. 2013).

Eighteen ash gourd genotypes (11 landraces collected from different districts of Odisha and 7 released varieties) were studied. Results revealed that in respect of fruit yield, the genotype Kashi Surbhi (10134.686 g/plant) was the best followed by Kashi Dhawal (7678.655 g/plant), Pusa Sabji Petha (6626.995 g/plant), Pusa Urmi (6376.530 g/plant) and BAGS-8 (6124.365 g/plant). Kashi Surbhi was also the earliest in respect of fruit setting while BAGS-2 was noted for highest number of female flowers per plant (39.50). The genotype BAGS-1 recorded the maximum number of fruits per plant (4.965) while fruit weight was highest in Kashi Dhawal. BAGS-7 produced maximum number and weight of seeds per fruit. The characters number of seeds /fruit and weight of seeds/fruit having high GCV, heritability and GA(%) are under the influence of additive gene action. It may be concluded that the genotypes Kashi Surbhi and Kashi Dhawal can be recommended for cultivation in Odisha (Pradhan et al. 2018).

Pandey et al. (2008) have attempted to assess the genetic diversity among 34 accessions of *Benincasa hispida* using quantitative traits and RAPD data. Variability was observed for characters like days to first female flower, fruit weight, equatorial and polar diameter. Cluster analysis based on quantitative traits revealed a high degree of diversity among the accessions. RAPD-based dendrogram showed dissimilarity values 0.64–0.943 suggesting that the accessions represent a genetically diverse population. A non-significant correlation was observed between the clustering based on quantitative traits and RAPD markers. But the accessions like IVAG-

107 and IVAG-81 clearly separated from rest of the accessions based on the quantitative traits and as well as RAPD primers. Both the dendrogram revealed that the accessions from Northeastern region of India are diverse from the accessions of other parts of India, as they cluster together in both the dendrogram. The information generated could be utilized in developing cultivars/hybrids for specific traits (Pandey et al. 2008).

Twenty-five diverse genotypes of ash gourd were evaluated to estimate variability, heritability and genetic advance over mean for fruit yield and yield component characters. Analysis of variance revealed significant differences for almost all the characters. High genotypic coefficient of variation was observed for fruits per plant, mean fruit weight, fruit yield per plant, fruit length, fruit girth and flesh thickness, which indicate that there exists high genetic variability and better scope for improvement of these characters through selection. The characters node to male flower, vine length, fruits per plant, mean fruit weight, fruit yield per plant, fruit length, fruit girth, flesh thickness, 100-seed weight, seeds per fruit and dry matter content had high heritability coupled with high genetic advance suggesting improvement of those characters through selection due to additive gene action. In the present study high heritability and low genetic advance was noted for days to first male and female flower indicating dominant gene action (Lovely and Kumar 2017).

Forty six genotypes of ash gourd were evaluated to determine genetic variability, heritability and genetic advance for nineteen contributing characters during the 2016-17. Significant variations were recorded for the various characters studied. Widest range of variation was observed in number of seeds per fruit followed by duration of crop, days to first fruit harvest, days to 50% flowering, days to fruit set, days to first female flower appears, days to first male flower appears, fruit girth (cm), node number of first female flower appears, node number of first male flower appears, fruit length (cm), fruit yield per hectare (q), number of branches per plant, number of fruits per plant, vitamin C (mg/100 g). Maximum genotypic and phenotypic coefficient of variation (GCV and PCV) was observed for number of seeds per fruit, fruit yield per ha in (q), 100 seed weight (g), average fruit weight (kg), fruit length(cm). High magnitude of heritability was recorded for most of the characters. The highest heritability were recorded for the characters, number of seeds per fruit (94.7%), followed by fruit yield/ha (q), (94.3%), 100 seed weight (93.8%) average fruit weight(kg) (92.2%), fruit length (cm) (90.9%), number of fruits per plant (88.05%) fruit girth (cm) (81.9%) number of branches per plant

(78.1%) node number of first male flower appears (77.8) node number of first female flower appears (76.4%) and T.S.S. (%) (74.1%). The maximum genetic advance as percentage of mean was observed for number of seeds per fruit (55.01%), fruit yield per ha(q) (52.79%), 100 seed weight (50.85%), average fruit weight (kg) (49.66%), fruit length (cm) (41.62%), number of fruits per plant(33.60%), fruit girth (cm) (25.03), node number first male flower appears (23.21%), number of branches per plant (21.88%), node number of first female flower appears (21.37%), On the basis of this investigation selection criteria are number of seed per fruit bringing out the improvement in ash gourd because they appearance with high value of GCV, PCV, heritability and genetic advance (Bairwa et al. 2017).

Genetic Resources

Dhillon et al. (2016) reported that the world Veg listed 285 ash gourd accessions in its gene bank in 2016; 13% (36) are available and 87% are inactive. FCRI Vietnam has more than 200 wax gourd accessions stored in its gene bank. In India more than 222 accessions are maintained in NBPGR, New Delhi. GRIN listed 106 ash gourd accessions in 2016 from six countries, including 21 from India and 57 from China. Thirteen (12%) GRIN accessions were available for distribution and 75 (71%) were inactive. Ebert et al. (2021) reported that at the global level, 1,650 ash gourd accessions are currently being conserved *ex situ*. The largest holder of ash gourd germplasm is the International World Vegetable Gene Bank (315 accessions), followed by national gene banks in China (300), India (270), Japan (261) and Bangladesh (323). Four major cultivar groups of ash gourd are recognized based on the vegetative, floral, fruit and seed traits (Walters and Decker-Walters 1989):

1. *Unridged winter melon group* comprises large cylindrical fruits (50–100 cm) with a dark-green rind that has little or no waxy bloom and unridged seeds. This group, along with the next two groups, is common in China and parts of western Asia.
2. *Ridged winter-melon group* is similar to the first group with the exception of its ridged seeds.
3. *Fuzzy gourd group* cultivars have small, narrowly cylindrical fruits (20–25 cm), light-green to green fruit skin covered with soft white hairs without waxy bloom and ridged seeds. This group is also common in Southeast Asia.
4. *Wax gourd group* predominates in India and other parts of South Asia. Fruits are covered with a white, waxy bloom; seeds are mostly ridged.

However, Marr et al. (2007) proposed 16 cultivar groups based on the wide range of fruit size, color, shape and intensity of waxy boom.

Breeding

The narrow genetic base of many cucurbit crop cultivars is a major challenge for breeders aiming to develop improved varieties with both abiotic and biotic stress resistance. Crop wild relatives and landraces may serve as sources of such genetic diversity and must be conserved *ex situ*. Improved technologies, especially genomics-assisted breeding, are facilitating the introgression of favorable traits from wild species into cultivars. To expedite the use of conserved diversity in breeding programs, the full characterization of gene bank collections is necessary. Mobilization of broad crop gene pool diversity will allow breeders to develop resistant cultivars adapted to rapidly changing environmental conditions, thus boosting agricultural production and ensuring food and nutritional security (Ebert et al. 2021).

Breeding methods such as mass selection, pedigree method, and bulk population are used for the ash gourd breeding (Mini Raj et al. 1993). To meet the diverse goals of plant breeding such as producing cultivars with increased yield, wider adaptation, desirable quality and pest and disease resistance we need to evaluate the existing genotypes at phenotypic and genotypic level. In India, there are many genotypes of ash gourd having different characters. A study of yield and its components and their relative contribution to the yield is of great importance in planning an effective breeding program (Dewan et al. 2013).

In India, a wide range of variability is available for different component characters in ash gourd but very sporadic efforts have been made for its genetic improvement. The fact that almost no hybrid is under cultivation reflects the negligence of crop improvement in ash gourd. Considering the potentiality of this crop, there is a need to develop varieties suitable for cultivation under specific agro-ecological conditions. A thorough knowledge regarding the amount of genetic variability existing for various characters is essential for initiating the crop improvement program. With limited variability, much improvement cannot be achieved, hence, the breeders will have to enrich the germplasm or they can resort to creation of greater variability through hybridization, mutation and polyploidy breeding. Development of productive and potentially ideal type is the main aim of any crop improvement program. It is also necessary to become familiar with the detailed genetic structure of germplasm material to be used in

hybrid breeding. Such studies are also useful in selection of parents for hybridization to recover superior transgressive segregants. Since such studies are very meager the present investigation was carried out with a set of varieties and landraces of ash gourd (Pradhan et al. 2018). Ash gourd is graft-compatible with muskmelon scion. This stock could be grown in areas affected by wilt caused by *Fusarium oxysporum melonis* as ash gourd lines show resistance to wilt (Mini Raj et al. 1993).

Cultivars/Varieties/Hybrids

Landraces are still grown by local people in different regions of Asia. Mo-kwa, a high yielding landrace, is heat-tolerant. Cultivar Chi-fon is popular in Taiwan, and is highly resistant to ZYMV, Cucumber mosaic virus, PRSV-W, and melon vein-banding mosaic virus. Ash gourd is an important crop in Vietnam, where it is cultivated on more than 33,000 ha annually (Dhillon et al. 2016).

The varieties developed in India

CO-1: A variety moderately resistant to insect-pests and diseases was developed at Tamil Nadu Agricultural University, Coimbatore through selection from a local collection. The vine trailing up to 4.0 m is moderately vigorous with dark green leaves. Fruits are globular, green, large, oblong, 35 cm long and 22 cm in girth with an average weight of about 6.8 kg. First harvesting is done about 100 days after sowing with an average yield of 20-25 t/ha in 140-150 days of crop duration.

CO-2: This variety was also developed at Tamil Nadu Agricultural University, Coimbatore. The green fleshed fruits are small long and spherical with an average weight of 3 kg. It gives an average yield of 34.4 t/ha in crop duration of about 120 days.

Mudliar: This variety was also developed at Tamil Nadu Agricultural University, Coimbatore and recommended for cultivation in Tamil Nadu state. Fruits are big and pale-green in colour.

Indu: A variety tolerant to mosaic diseases was developed at College of Horticulture, Vellanikkara through selection from an indigenous collection. Fruits are round, 24.3 cm long, and 23.78 cm in breadth with an average weight of 4.82 kg. It gives an average yield of 24.5 t/ha.

KAU Local: This variety was developed at College of Horticulture, Vellanikkara through selection from an indigenous collection and released by the State Seed Sub-Committee. Medium sized, fruits are oval to oblong in shape with a green colour at tender immature stage

and white at full maturity. The fruits are 45-55 cm long and length: breadth ratio 2.05 with an average weight of 6.1-8.1 kg. Flesh thickness is 5.1-6.2 cm. It gives an average yield of 28 t/ha in crop duration of 105-120 day for mature fruit production, however, harvesting at tender stage is advisable for better yield and market demand.

IVAG-502: This has been identified as a promising variety at Indian Institute of Vegetable Research, Varanasi with a vine length of 4.5-5.0 cm. White fleshed fruits with average weight of 12-13 kg are oblong in shape, having seed arrangement linear. It gives an average yield of 35-40 t/ha.

IVAG-90: This is also identified as promising variety at Indian Institute of Vegetable Research, Varanasi. Less seeded fruits with average weight of 10-12 kg are globular in shape. The average yield is 30-35 t/ha in crop duration of 110-120 days.

PAG-3: A variety tolerant to insect-pests and diseases was developed at Punjab Agricultural University, Ludhiana and released at state level. Medium sized fruits with average weight of 8-10 kg are globular in shape. Fruit colour is green at immature stage and covered with white shining coat at maturity. First picking of fruits starts 60 days after fruit setting. It yields 70-75 t/ha in a crop duration of about 145 days.

Karikumbala: Developed by UAS Bengaluru. It is a local cultivar where the fruits are covered with ashy coat.

APAU Shakthi: Developed by APAU, Hyderabad, fruits are long, cylindrical in shape. Yield is about 75 to 84 tons per acre with crop duration of 140 to 180 days.

Ekalavya: Developed by innovative farmer, Shri A.S. Joy of Thrissur, Kerala as a Hybrid. This is a Mosaic resistant variety. Fruits weigh 12 Kg. Crop duration 140 days. Yield is 25 tonnes per acre.

Pusa Urmi (F₁ hybrid): The fruits are oblong-ellipsoid with greenish white rind and white flesh. The average fruit weight is 10.0 kg and average number of fruits/plant is 4.60 with an average yield of 47.5 tonnes/ha. It is recommended for commercial cultivation in Rajasthan, Gujarat, Haryana, Delhi, Karnataka, Tamil Nadu and Kerala. It is tolerant to cucumber mosaic virus and watermelon mosaic virus.

Pusa Shreyali (F₁ hybrid): The fruits are elliptical-oval with green rind and average fruit weight is 9.0 kg and 4 fruits/plant with an average yield of 41.6 tonnes/ha. It is recommended for Punjab, Uttar Pradesh, Bihar and Jharkhand. It is tolerant to cucumber mosaic virus and watermelon mosaic virus.

Pusa Sabji Petha: Its vines are medium long (7.0 m) and fruits are cylindrical & suitable for culinary purpose. It requires 100-110 days for first fruit maturity. Average yield is 36.5 t/ha and fruit weight is 3.5 kg. This variety is identified for Kharif cultivation in Karnataka, Tamil Nadu and Kerala.

Pusa Ujjwal: Developed through selection. Fruits are oblong, ellipsoid, rind greenish white with whitish flesh average fruit weight of 7.0 kg. Its fruits are ideal for long distance transportation. Average yield is 45 t/ha. It is recommended for cultivation in the states of Karnataka, Tamil Nadu and Kerala

Kashi Dhawal: This variety is derived from a local collection. The vine length is 7.5-8 m. Fruits are oblong, flesh white, thickness 8.5-8.7 cm, seed arrangements linear, average weight 11-12 kg crop duration 120 days and yield 550-600 q/ha. This is suitable for preparation of Petha sweets due to high flesh recovery. This has been identified by UP State Horticultural Seed Sub Committee and notified during the XII meeting of Central Sub Committee on Crop Standard Notification and Release of Varieties for Horticultural Crops for the cultivation in U.P., Punjab, Bihar and Jharkhand.

Kashi Surbhi: Fruits oblong, ellipsoid, rind greenish white, flesh white; Average fruit weight 10-12 kg; Fruits are suitable for long distance transportation; It has yield potential of 600-700 q/ha (Kharif season) and 510-550 q/ha (summer season).

Kashi Ujjwal: High yielding (60.0 t/ha), suitable for candy/petha. This variety has been recommended for cultivation in the states of Punjab, Uttar Pradesh, Bihar, Jharkhand, Karnataka, Tamil Nadu and Kerala and notified through Central Variety Release Committee.

Conclusion

Due to the presence of considerable variability in ash gourd crop, there is a possibility for breeding varieties which are bushy and with higher protein content of fruit.

Lkjk k

पेटा (*बेनिनकासा हिस्पिडा*) कुकुरबिटेसी कुल का सदस्य है जो विश्व के उष्ण व उपोष्ण जलवायु क्षेत्रों में उगायी जाती है। फलों का उपयोग कच्चा (आमतौर पर पकाकर या अचार बनाकर) या पके अवस्था में सूप एवं मिठाई बनाने के लिये किया जाता है। पोषकीय मूल्यों के अलावा पेटा का उपयोग आयुर्वेदिक दवाईयों तैयार करने के लिये किया जाता है। वर्तमान में पेटा पर प्रजनन शोध का ध्यान केन्द्रित है आनुवांशिक विविधता का आंकलन करना एवं ओज संभावना का पता लगाना। पेटा सम्बन्धित अनुसंधान उन्नयन या प्रगति के उद्भव स्थल व भौगोलिक वितरण, वर्गीकरण, वानस्पतिक

विवरण, आनुवांशिक विविधता, आनुवांशिक संसाधनों एकत्रीकरण, आनुवांशिक उन्नयन (किस्म समूह, उपयोगिता, प्रजनन व किस्मों/संकरों) फलों का पोषकीय मूल्य, फलों से स्वास्थ्य लाभ, पेटा जूस, संजातीय/सांस्कृतिक महत्वों की समीक्षा इस आलेख में की गयी है। यह समीक्षा आलेख पेटा पर बुनियादी एवं व्यवहारिक अनुसंधानों पर आधारित सन्दर्भों को प्रस्तुत करता है।

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