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REVIEW ARTICLE

ORIGIN, DISTRIBUTION, TAXONOMY, BOTANICAL DESCRIPTION, GENETIC DIVERSITY AND BREEDING OF POINTED GOURD (*Trichosanthes dioica* Roxb)

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ABSTRACT

Pointed gourd (*Trichosanthes dioica* Roxb.) is one of the most important cucurbit vegetables in tropical and subtropical regions of the world, particularly in India and Bangladesh. Pointed gourd is morphologically distinct from other cucurbitaceous species due to its well-established dioecism, perennial nature, and vegetative means of propagation. The pointed gourd having the common Indian names of "Parwal", "Parmal", "Panal" and "Patal". This important crop is widely grown in the eastern Uttar Pradesh, Bihar, West Bengal, Assam, Odisha, Madhya Pradesh, in some parts of Maharashtra and Gujarat and some hilly tracts of Andhra Pradesh and Tamil Nadu. This perennial vine crop survives for long time through giving rise to sprouts from the tuberous roots even left uncared. The estimated area and production of pointed gourd in India during 2018-19 are 55,000 ha and 7,40,000 MT respectively. Fruits of pointed gourd are rich in proteins and vitamin A and also possess medicinal properties that can lower blood sugar and serum triglycerides. Fruits are consumed in a variety of ways, including vegetable curry, pickled, and as various confections. They have prolonged market availability, and the high nutritional and medicinal values of pointed gourd fruits make them a wholesome vegetable. Seed propagation of pointed gourd is undesirable due to poor germination and unpredictable variation; thus, pointed gourd is multiplied through stem and root cuttings. Hybridization followed by selection among segregating progeny and clonal selection are promising approaches for genetic improvement of this species. In this review article, origin, distribution, taxonomy, botanical description, breeding, uses, nutritional value and health benefits of pointed gourd are discussed.

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INTRODUCTION

Cucurbits are found predominantly in subtropical and tropical regions of the world since they are frost sensitive (Robinson and Decker-Walters, 1999). Cucurbits are well known for their economic, cultural, and culinary value and are important crops worldwide. Generally, they are highly adaptable, fast-growing vines with tendrils, and many bear relatively larger fruits (Robinson and Decker-Walters, 1999). India has a rich source of cucurbits and is believed to be the primary or secondary center of origin for species such as *T. dioica*, *T. anguina*, *M. charantia*, *M. dioica*, *M. cochnchinensis*, and *P. fistulosus* (Choudhury, 1996; Gopalkrishnan, 2007; Pandey, 2008). The perennial pointed gourd is a nutritious cucurbit vegetable and is highly coveted in the vegetable markets of India and Bangladesh from February to September (Singh and Whitehead, 1999). In India, it is called *parval* or *green potato*. It is widely cultivated in the eastern and some northern parts of India, particularly in the states of Bihar, eastern Uttar Pradesh, West Bengal, and Assam and to some extent in Odisha, Madhya Pradesh, Maharashtra, and Gujarat. (Some *et al*., 1993; Manoj, 2019; WIKI, 2022). The estimated area and production of pointed gourd in India during 2018-19 are 55,000 ha and 7,40,000 MT respectively (NHB, 2022).

The green, tender fruits of pointed gourd are consumed as a vegetable; however, new, tender shoots and leaves are also used as vegetables (Some *et al*., 1993). Young fruits of pointed gourd are cooked, pickled, and used in confections (Paris and Maynard, 2008), and young leaves and shoot- tips are also consumed (Anon., 1998). It is used as an ingredient for soup, stew, curry, sweet, or eaten fried and as *potoler dorma* or *dolma* (dolma) with fish, roe or meat stuffing. Parval is also used to make *kalonji*, a deep fried cuisine filled with spices (WIKI, 2022). A famous sweet by putting the fruits in sugar syrup is made in India (Manoj, 2019). Pointed gourd is an asexually propagated, perennial vegetable crop. This crop is highly cross-pollinated due to dioecy and is thereby heterozygous in relation to the seedlings (Some *et al*., 1993). The clones are heterozygous and this situation is maintained indefinitely by vegetative propagation (Som *et al*., 1993). It contains 2% protein, 0.3% fat, 2.2% carbohydrates, 153IU vitamin A, and 29 mg vitamin C per 100 g edible portion (Manoj, 2019). It is easily digestible, diuretic, and laxative. It also invigorates the heart and brain and is useful in the disorders of the circulatory system. The fruits show some prospects in the control of certain cancer-like conditions (Some *et al*., 1993). Fruit is particularly used in convalescence. It is easily digestible and it is diuretic, laxative, cardiatonic. It is also recommended for bronchitis, fever and nervousness (Manoj, 2019).

Common Names in India: Sanskrit name – Patota, Lulka, Tikta, Panduka, Rajiphata, Amritphala, Pratika, Kushthaha, Meki, Parvara, Kulaka, Nagaphala, Karkashcchada, Tiktottama; English Name – Pointed gourd, wild snake guard; Gujarati name – patota, patal; Punjab name - parwal, palwal; Hindl name – parval; Telugu name – kummupotla / chedupotla; Bengll name – patol; Marathi name – paravat; Tamil name – kambupudalai; Kannada name – kaadu padaval, kadu padavalakayi; Malayalam name – patolam; Oriya – patal; Urdu – prora (Meenakshi, 2019; Jagdish, 2019).

ORIGIN AND DISTRIBUTION

Trichosanthes is a large genus, principally of Indo-Malayan distribution with about 44 species of which 22 are found in India. Much earlier, De-Candolle (1882) recorded in his "Origin of Cultivated Plants" the species of *Trichosanthes,* especially T. dioica as being of Old World origin, most probably India. The proposition of Assam-Bengal region as the primary centre of origin of pointed gourd advanced by Choudhury (1979) was based on the rich diversity of this crop in this region including Bangladesh. *Trichosanthes* is a large genus of Indo-Malayan distribution, with about 44 species, of which 22 are found in India (Chakravarty 1982; Some *et al*., 1993; Lybrate, 2020; Adhiyamaan, 2022). The name *petola* or *patala*, which signifies snake gourd (*Trichosanthes cucumerina*) in Malay Peninsula and Philippine islands, is of Sanskrit origin (*patola*), indicating that the genus *Trichosanthes* may be indigenous to India (Seshadri and Parthasarathy 2002). Choudhury (1996) concluded that the Assam-Bengal region of India was the primary center of origin because this region, including Bangladesh, exhibits a rich species diversity of this crop. However, wild forms of T. dioica are found throughout northern India. According to RBG (2022) it is native to Assam, Bangladesh, East Himalaya, India, Myanmar, Nepal, Pakistan, Sri Lanka, West Himalaya. It is cultivated widely in the eastern parts of the country and in the plains of North India from Punjab to Assam. It is also extensively cultivated in Bihar, Odissa, Assam and West Bengal **(**Lybrate, 2020**).**

TAXONOMY

Sponge gourd belongs to the family Cucurbitaceae, subfamily Cucurbitoideae, tribe Sicyoeae, genus *Trichosanthes, and species Trichosanthes dioica*Roxb. (WIKI, 2021; WIKI, 2022; Adhiyamaan, 2022). Yueh and Cheng (1980) subdivided genus *Trichosanthes* on the basis of the male bract, fruit pulp, and seed characters into subgenera *Cucumeroides* (with two sections: *Cucumeroides* and *Tetragonosperma*) and *Trichosanthes* (into five sections: *Foliobracteola, Involucraria*, *Pedatae*, *Trichosanthes*, and *Truncata*). In contrast, Jeffrey (1980) listed five sections of genus *Trichosanthes* (*Cucumeroides*, *Foliobracteola*, *Involucraria*, *Trichosanthes*, *Truncata*), without mentioning subgenera.

Selected species of *Trichosanthes* (WIKI, 2021)

- *Trichosanthes* baviensis Gagnepain
- *Trichosanthes* cochinchinensis (Lour) M. Roem.
- *Trichosanthes* cucumerina – Serpent gourd, Padwal
- *Trichosanthes cucumerina* var. *anguina* – Snake gourd
- *Trichosanthes* dioica – Pointed gourd, parwal (Hindi), potol / *potals* (eastern India & Northeastern Andhra)
- *Trichosanthes* dunniana Levl.
- *Trichosanthes* fissibracteata C.Y.Wu ex C.Y.Cheng & Yueh
- *Trichosanthes* globosa Blume
- *Trichosanthes* homophylla Hayata
- *Trichosanthes* kerrii Craib
- *Trichosanthes* kinabaluensis Rugayah
- *Trichosanthes* kirilowii – *"gualou"* (China) (= *T. japonica*)
- *Trichosanthes* laceribractea Hayata
- *Trichosanthes* lepiniana (Nuad.) Cogn.
- *Trichosanthes* montana Rugayah
- *Trichosanthes* pedata Merr. & Chun
- *Trichosanthes* pendula Rugayah
- *Trichosanthes* pilosa (Ser.) Maxim in Franch. & Sav. - Japanese snake gourd.
- *Trichosanthes* pentaphylla F.Muell. ex Benth.
- *Trichosanthes* postarii W.J.de Wilde & Duyfjes
- *Trichosanthes* quinquangulata A.Gray
- *Trichosanthes* reticulinervis C.Y.Wu ex S.K.Chen
- *Trichosanthes* rosthornii Harms – *"gualou"* (China) (= *T. uniflora*)
- *Trichosanthes* rubiflos Thorel ex Cayla
- *Trichosanthes* rugatisemina C.Y.Cheng & Yueh
- *Trichosanthes* schlechteri Cogn. ex Harms
- *Trichosanthes* sepilokensis Rugayah
- *Trichosanthes* sericeifolia C.Y.Cheng & Yueh
- *Trichosanthes* subrosea C.Y.Cheng & Yueh
- *Trichosanthes* subvelutina F.Muell. ex Cogn.
- *Trichosanthes* tricuspidata Lour. (= *T. bracteata, T. palmata*)
- *Trichosanthes* truncata C.B.Clarke
- *Trichosanthes* villosa Blume
- *Trichosanthes* wallichiana (Ser.) Wight
- *Trichosanthes* wawraei (Ser.) Xianyu.W

Classification of *Trichosanthes* at the species level was originally carried out by Kundu (1942) and later revised by Chakravarty (1982). Seed coat anatomy is diverse in different species of *Trichosanthes Trichosanthes*, *T. dioica*. Tiwari *et al*. *T. dioica* and *T. anguina*, (Sikdar *et al*. 2010). (Singh and Dhatan 1976). Although protein patterns are similar in a few high-molecular-weight proteins are detected only in (1990) using paired affinity and group affinity values of 17 isozymes in 13 cucurbit species, reported 71% similarity between but these similarities were not substantiated with DNA-based studies Among the different species of the most common species in India, whereas most common cultivated species followed by and One synonym present viz., Anguina dioica (Roxb.) Kuntze *Trichosanthes*, *T. bracteata* is *T. dioica* is the *T. cucumerina*, *T. anguina* (Anon. 1998). of *T. dioica* is .

BOTANICAL DESCRIPTION

Pointed gourd being (*T. dioica)* is distinct from other cucurbits due to its well-established dioecism and perennial nature (Meenakshi, 2019; Mousumi, 2022).

Plant: Pointed gourd has tuberous roots and a long taproot system. Plants grow as a vine (Figs. 5.1 and 5.2a), which can extend up to 5–6 m. The stem is generally 0.5–1.0 cm thick with simple tendrils, and the dark green leaves are simple and cordate. Typically, each node on the staminate plant bears a leaf on a long pedicel, a simple bifid or sometimes unbranched tendril, and a glandular bract; it may also have one or sometimes two solitary staminate flowers. In pistillate plants, flowers are present in leaf axils (Meenakshi, 2019).

Flowers: Inflorescence is recimose; flowers are sessile, solitary, bracteate with oblong-cylindrical calyx tube (Pandit and Hazra, 2008). Staminate flowers contain three stamens with short filaments deeply inserted on calyx tube; anthers are syngenesious, rarely free, without any staminodes (Pathak and Singh, 1950). Pollen grains are round with three weak pores (3-zoniporate), oblate spheroidal (diameter 52–56 mm), and pores are circular (diameter 4.2 mm), provided with an annulus (Awasthi, 1961). Pistillate flowers have slender styles ending in 3 papillate stigmas, where the gynoecium has 5 carpels (Pandit and Hazra, 2008). The ovary is oblong, ovoid, fusiform, globose with many horizontal, semipendulous ovules. Occasional hermaphrodite flowers with rudimentary or even well-developed anthers have been reported by some workers on otherwise pistillate plants (Baillon, 1922; Singh, 1950; Singh *et al*., 1992), mostly during the months of April to August (Singh *et al*., 1992). Spray application of 1,000 mg/l silver nitrate (AgNO3) on pistillate flowers induces hermaphroditic flowers of abnormal size and shape that typically do not shed pollen (Hoque *et al*., 2002). Normally, a node in the male plant bears a leaf, one or two solitary male flowers on distinct pedicels, a simple or bifid tendril, a vegetative shoot and a glandular bract, while that of the

female plants also bear the same parts except one or two (sometimes even four) female flowers on very short and indistinct peduncles. The female flower, which is terminated by three bilobed or divided stigmas, is 1-5 (usually 3) carpellary, thick, and short styled (Mousumi, 2022). Flowers are white color with a tubular appearance. Flowers of this plant are dioecious type. The male flowers are not strobile (conelike). Stigma remains viable for about 14 hours and 40–70% of flowers set fruit (Meenakshi, 2019).

Fruits: The fruit (pepo) of *T. dioica* are globose, oblong, and smooth, where the edible portion is mainly the pericarp with a little mesocarp (Pandit and Hazra, 2008). Fruit is globose, oblong, and smooth, 2 to 6 inches (5 to 15 cm) long glabrous, orange-red, pointed at both ends. They are green with white or no stripes. They are yellowish-green color when young turning to burnt orange color as they mature (Meenakshi, 2019. Creamy white flesh consists of sub globose seeds that are 6-7 mm long, 5-6 mm broad. They have bland flavor and as they mature they are tasteless. Fruit, the main economic part, is botanically the 'pepo' the edible portion being mostly pericarp with little mesocarp. Fruits are not with high contents of bitter principle, cucurbitacin, which is commonly found in roots, shoots, and leaves (Mousumi, 2022). Seeds are globose (Adhiyamaan, 2022) (Fig. 1). Their roots are tube like structure, have tuberous property with long tap root system to manage the plant processes (Meenakshi, 2019). Roots are tuberous with long tap root system (Adhiyamaan, 2022). Based on fruit shape, size and striations in them Singh (1989) and HBT (2022) considering seventeen growth and fruit characters of the female clones into five groups viz., 1) Long, dark green with white stripes, 2) Thick, dark green with very pale green stripes 10-16 cm long, 3) Roundish, dark green with white stripes, 5-8 cm long, 4) Tapering, green and white stripes, 5-8 cm long, and 5) Pale white, oval fruits without any markings (Popular in M.P.) (Fig. 2). The first four types are mostly grown in Bihar, Orissa, Uttar Pradesh, and West Bengal states of India. In contrast, in Madhya Pradesh, a fifth type is popular consisting of cultivars having pale-white oval fruits without any markings (More and Shinde, 2003) (Fig. 2).

Floral Biology: As a dioecious species, *T.* dioica is strictly cross-pollinated, thereby avoiding the deleterious effects of inbreeding, and it maintains a high population heterozygosity (Singh, 2005). In India, flowering in *T. dioica* starts in February and continues until November. The transmission from vegetative phase to reproductive phase is accompanied by a significant increase in the GA3 level. The increase in staminate plants is higher than that of pistillate plants (Sarkar and Datta, 1990). Generally, two flower buds arise from the same leaf axil in staminate plants where one or sometimes both develop further. In pistillate plants, two flower buds arise in the leaf axil, and typically the first floral bud develops (Pathak and Singh, 1950; Peter *et al*., 1998). Singh (1950) reported that temperature was the main factor affecting the time of anthesis and dehiscence of anthers, while relative humidity had little effect. Pollen grains are sticky and are not suitable for wind pollination. The pollen remain viable for up to 46–49 hours, while the stigma becomes receptive 7 hours before anthesis and remains so up to 51 hours after anthesis. Zaman (2006) investigated 14 cucurbit species and reported the lowest pollen viability (87%) and germination (78%) in T. dioica. Pollen tube development in cucurbitaceous plants has been investigated by Stephenson *et al.* (2003). Staminate flowers have longer floral tubes and take longer (16–19 days) to reach anthesis than pistillate flowers (10–14 days) (Singh *et al*., 1989). Anthesis commences between 7:00 and 19:00 and continues up to 21:00. Pollen viability is quite high (ca. 98%) at anthesis but gradually declines to zero 54 h after anthesis. In contrast, the stigma remains receptive up to 24 hours after anthesis. Under natural open pollination, fruit set is low, mainly due to poor pollination (Pathak and Singh, 1950), but fruit set can be increased by hand pollination (Fig. 3).

CYTOLOGY AND GENETIC DIVERSITY

Cytology: The chromosome number of *T. diocia* is 2n= 2x= 22 with 11 bivalents in pollen mother cells (Banerjee and Das 1937; Sarkar and Dutta 1988; Sarkar *et al*., 1987; Sinha *et al*., 2003).

Plants of *T. dioica* typically have more than 3 chromosomes with secondary constrictions (Sarkar and Datta 1988; Sarkar *et al*., 1987;). Giemsa C-banding pattern in three cultivars of T. dioica revealed distinct telomeric bands in the somatic chromosomes, which could be used to distinguish cultivars (Sarkar and Dutta, 1987). An analysis of meiotic behavior of chromosomes in *T. dioica*, *T. cucumerina*, *T. anguina*, and *T. palmata* indicated a marked similarity in the general chromosome morphology (Sarkar *et al*., 1987).Most workers (Chattopadhyay and Sharma, 1988; Sinha *et al*., 2007) maintain that staminate and pistillate individuals of *T. dioica* do not differ in chromosome morphology, number of secondary constrictions, and total chromosome length, but some workers reported one hetero- morphic chromosome pair in staminate plants (Sarkar and Datta, 1988; Sarkar *et al*., 1987).

Further, mitotic metaphase chromosomes of staminate plants show a higher DNA condensation than those of pistillate plants, possibly indicating the inactivation of certain chromosome segments in staminate plants (Sinha *et al*., 2007). Pistillate plants of *T. dioica* show diffuse C-banding in a single pair of chromosomes while the staminate plants do not (Sarkar and Dutta, 1987). During metaphase I in pollen mother cells, one chromosome pair remains separate from the remaining bivalents on a different plane (Patel, 1952; Sarkar and Dutta, 1988). At anaphase I, this pair showed an earlier separation than the rest of the chromosome pairs in cultivated T. dioica but separated later in the wild form (Sarkar and Dutta, 1988). These observations suggest that at present there is little evidence that sex difference in *T. dioica* are correlated with difference in chromosome morphology (Chattopadhyay and Sharma, 1991; Sinha *et al*., 2007).

Genetic Diversity: A wide range of quantitatively and qualitatively inherited phenotypic variation in plant vigor, morphology, reproductive traits, and fruit size and shape is present in pointed gourd accessions from India (Singh and Prasad, 1989; Prasad and Singh, 1990b; Hazra et al., 1998; Dora et al., 2001; Ram, 2001). The exploitation of this variation should form the basis for hybridization programs and subsequent selection of elite clones. Accessions collected from different parts of Northern India show significant differences for number of primary branches, fruit length, individual fruit weight, fruit volume, pulp weight, and yield per plant (Chandra *et al*., 1995; Kabir *et al*., 2009). High heritability (52.0–91.0) andgenetic advance (8.18–9.21) have been reported for fruit length, fruit volume, and fruit yield per plant (Singh and Prasad, 1989).

Positive heterosis has been reported for fruit weight, dry matter content, and fruit yield per plant/harvest (Singh *et al*., 2000; Sadat *et al*., 2008). Yield per plant shows significant positive correlation (0.287–0.983) with fruit weight, fruit diameter, fruit volume, vine length, fruit length, and number of primary branches (Sarkar *et al*., 1999), while node at which first pistillate flower appears, skin thickness, and internodal length exhibit negative correlation with yield (Dora *et al*., 2002).

Nonhierarchical cluster analysis of leaf and stem morphology and yield-contributing traits revealed that the accessions having thin and slender stem along with bushy habit possess early fruiting (Ram, 2001). Cultivars such as 'Swarna Rekha' and Swarna Alaukik' show yield stability over different environments and thus are suitable for commercial cultivation (Prasad and Singh, 1990a; Prasad *et al*., 1999). The variation in sexual progeny for plant vigor, onset of flowering, fruit size and shape, and stem and leaf morphological traits indicate a high levels of heterozygosity and heterogeneity in clones. There is also considerable variation for stem pubescence (pubescent dominant over smooth), stem shape (angular dominant over round), tendril coiling (coiled dominant over straight), tendril branching (branched dominant over unbranched), and leaf pubescence (smooth dominant over pubescent). A single gene has been proposed to control stem pubescence (*sst*), stem shape (*rst*), tendril coiling (*stl*), tendril branching (*utl*), and leaf pubescence (*plf*) (Kumar *et al*., 2008a).

Pointed gourd plant

Leaf of pointed gourd

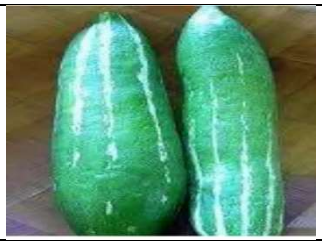
Flower

Pointed gourd on the plant

Half cut pointed gourd

Pointed gourd matured seeds

Fig. 1. Botanical description of pointed gourd



1. Long, dark green with white stripes

2. Thick, dark green with very pale green stripes, 10-16 cm long

3. Roundish, dark green with white stripes, 5-8 cm long

4. Tapering, green and white stripes, 5-8 cm long

5. Pale white, oval fruits without any markings (Popular in M.P.)

Fig. 2: Grouping of pointed gourd varieties based on fruit shape, size and striations

Fig. 3. Pollination of pointed gourd

There is a marked bias in favor of pistillate over staminate plants in progeny, possibly due to lethal or sublethal gene(s) linked to the pistillate determining locus

(Kumar *et al*., 2008a). The genetic diversity among 64 pointed gourd genotypes were assessed through multivariate analysis from an experiment. The genotypes were grouped into twelve clusters. The cluster V consisted of highest number of genotypes and it was nine, the cluster VI and cluster VIII contained the lowest number of genotypes and it was two in each. The clustering pattern of the genotypes under this study revealed that the genotypes collected from the same location were grouped into different clusters. The genotypes of Jessore were distributed in different clusters. The highest inter genotype distance as 366.3 observed between the genotypes P0022 and P0007 and the lowest 2.6 as observed between the genotypes P0043 and P0044. Cluster V had the highest cluster mean value for internode length, fruit weight per plant and yield the highest inter-cluster distance was noticed between cluster III and II (45.71) and the lowest between cluster VII and VI (3.33). 'The highest intra cluster distance was computed for cluster III and that was lowest for the cluster II. The first five axes accounted for 77.65% of the total variation among the 13 characters describing 64 pointed gourd genotypes. Fruit weight, seeds per fruit and fruit weight per plant contributed maximum to the total divergence. The results obtained by D 2 analysis were confirmed by canonical analysis (Khan *et al*., 2008).

Genetic variation in 64 pointed gourd accessions was investigated using the Random Amplified Polymorphic DNA (RAPD). Out of 45 random primers screened five were selected, which gave 38 clear and bright fragments, out of which 30 (79.5%) fragments were considered polymorphic. The proportion of polymorphic loci across all loci was 96%. The number of bands per primer was five to eleven. The highest genetic distance 0.6419 was observed between the accession PG035 and PG051, PG035 and PG056 and PG035 and PG021. While the lowest genetic distance 0.00 was observed between the accession PG042 and PG043 and PG042 and PG044. The UPGMA dendogram constructed based on RAPD analysis in 64 pointed gourd accessions were found to be grouped in twelve major clusters. Cluster VIII is a broad one which includes 21 accessions and only a single accession formed in cluster VII (PG021). RAPD analysis showed promise as an effective tool in estimating genetic polymorphism in different accession of pointed gourd (Khan *et al*., 2009). Biochemical characterizations of 64 pointed gourds were done using three isozymes viz., acid phosphatase, peroxidase and glutamate oxaloacetate transaminase. A wide range of diversity among the gremplasm based on their acid phosphatase, peroxidase and glutamate oxaloacetate transaminase isoenzyme banding patterns were observed. In respect of isoenzyme activity; 8 acid phosphatase, 7 peroxidase and 9 glutamate oxaloacetate transminase electrophoretic zymotypes were formed by 19, 11, and 19 bands at different Rf values varying from 0.19 to 0.82, 0.38 to 0.69 and 0.15 to 0.95, respectively. The wide range of similarity co-efficient of 0.0-80.0, 0.0-66.0, and 0.0-80.0 as found among the electrophoretic patterns in acid phosphatase, peroxidase, and glutamate oxaloacetate transminase, respectively, indicating wide genetic diversity among the accessions. Based on the polymorphic activity of these three enzymes, 27 combinations of electrophoretic zymotypes were identified, each of which can be equated to genotypes. Each of the groups consisted of one to eight genotypes. Sixty four accessions of pointed gourd were grouped into 12 clusters. The genotypes collected from the same location were grouped into different clusters (Khan *et al*., 2009a). The experiment was conducted to estimate the genetic diversity among 24 genotypes of pointed gourd by using Mahalanobis D 2 statistics for nine characters. The genotypes were grouped in to five clusters. The cluster I and III consisted of highest number of genotypes and it was six. The cluster IV contained the lowest number of genotypes and it was three. The clustering pattern of the genotypes under this study revealed that the genotypes collected from the same location were grouped into different clusters. The genotypes of Kushtia were distributed in different clusters. The inter cluster distance were larger than the intra cluster distance suggesting wider genetic diversity among the genotypes of different groups. The highest intra cluster distance was computed for cluster IV (35.80) and the minimum intra cluster distance was found in cluster III (18.37). The clusters IV and II were more diverse as indicated by maximum inter cluster distances between them (41.56) and the minimum inter cluster divergence was observed between cluster III and II (6.84). Cluster II had the highest cluster mean value for number of fruits per plant (391), weight of fruit per plant (11.72kg) and yield (35.28t/ha). Genotypes of the cluster V had late maturity (Kabir *et al*., 2009). The genetic diversity of 10 pointed gourd races, referred to as accessions was evaluated. DNA profiling was generated using 10 sequence independent RAPD markers. A total of 58 scorable loci were observed out of which 18 (31.03%) loci were considered polymorphic. Genetic diversity parameters [average and effective number of alleles, Shannon's index, percent polymorphism, Nei's gene diversity, polymorphic information content (PIC)] for RAPD along with UPGMA clustering based on Jaccard's coefficient were estimated. The UPGMA dendogram constructed based on RAPD analysis in 10 pointed gourd accessions were found to be grouped in a single cluster and may represent members of one heterotic group. RAPD analysis showed promise as an effective tool in estimating genetic polymorphism in different accessions of pointed gourd (Adhikari *et al*., 2014). The genetic diversity among thirty six genotypes of pointed gourd was assessed from an experiment conducted at Pantnagar . Thirty six genotypes of pointed gourd were grown in Augmented Block Design II with three checks (Kashi Alankar, Swarna Rekha and Rajendra Parwal-1). All the thirty nine genotypes of pointed gourd were classified into seven non-overlapping clusters on the basis of D2 analysis and maximum inter-cluster distance were found between cluster VII and IV (72.42). This indicates that inter genotypic crosses between the members of cluster VII and IV would exhibit high heterosis and is also likely to produce new recombinants with desired traits. High cluster mean value for total soluble solid (4.13), number of primary branches (8.46), vine length (7.74) and nodes per vine (77.45) were presented in cluster III, however cluster I perceived genotypes with highest mean value for fruit length (9.35), fruit dry matter (7.24). Among the various traits studied, number of fruits per plant contributed the maximum (84.48%) towards divergence. A total of eight principal components were identified with principal component analysis which accounts 83.63 per cent of total variation (Debata1 *et al*., 2017). In order to determine the magnitude of variability, 35 genotypes of pointed gourd have been evaluated at, Pantnagar. Through analysis of variance, a high significant difference was found for almost all characters indicating a greater opportunity of exploit variability. PPG-26 has obtained highest mean for fruit length (10.39) and PPG-2 for fruit diameter (4.35) while PPG-31 genotype was resulted as the earliest among all. High GCV along with high PCV was found for the characters like Number of seeds per fruit (33.22 and 33.45), Fruit yield (q/ha) (31.38 and 33.09), Node number to first female flower (29.39 and 30.26) and Number of fruits per plant (29.29 and 29.70). Whereas, high heritability coupled with greater genetic advance was observed for number of fruit per plant and fruit yield per hectare which indicates that these characters are govern with additive gene effect with minimum environment effect so we can go for direct selection of pointed gourd genotypes for further improvement (Verma *et al*., 2017).

BREEDING

Development of improved cultivars of pointed gourd has been based primarily on selection from domesticated clones (Singh, 1989; Singh and Whitehead, 1999), but recently some hybrids have been obtained by crossing domestic clones (Kumar, 2008; Kumar *et al*., 2008a; Sadat *et al*., 2008). The choice of cultivar generally depends on regional consumer preferences for fruit shape, color, and striation pattern. The main breeding objectives are developing high-yielding selections having disease and pest resistance.

Breeding Methods

As pointed gourd is highly cross-pollinated, it shows considerable heterozygosity (Kumar *et al*., 2008a), and selection of individual plants with desirable characteristics from local and popular clones may form the basis of a new cultivars.

Several selections have been recommended for commercial cultivation, and at least two clonally propagated F1 hybrid selections have been released for commercial cultivation. Once a plant with vigor and desirable features is obtained, it is easily maintained by vegetative propagation to become a new cultivar. The use of hybrid seed is not practical because of poor germination (Some *et al*., 1993)

Varieties: Extensive clonal variation in this crop exists in West Bengal, Assam, Tripura, Bihar, and Eastern part of Uttar Pradesh because heterozygous nature and asexual propagation lead to large number of diverse cultivars on farmers' field. A large number of cultivars and horticultural forms of pointed gourd having restricted local distribution have been developed in different growing areas of India and Bangladesh. The fruits of pointed gourd cultivars are available in the market under different local names without any uniformity and standardization in nomenclature (Hossain and Razzaque, 1999). Although there is substantial intraspecific variation in pointed gourd vegetative traits, especially fruit characters, it is difficultto distinguish genotypes based on their external morphology alone (Hossain and Razzaque, 1999). In India, four high-yielding clones (Rajendra Parwal-1, Rajendra Parwal-2, Swarna Rekha, and Swarna Alaukik) have been developed through hybridization and/or selection have been released in India by the Central Variety Release Committee (CVRC) for cultivation in different agro-ecological zones (Singh *et al*., 2009). In addition, a large number of local selections known by names of localities such as 'Faizabad Parwal-1, 'Hilli', 'Chhota Hilli', 'Dandali', 'Kalyani', 'Bihar Sharif, and 'Santokhiya' are also very popular among the farmers (Singh *et al*., 2009).

Varieties of pointed gourd grown in India are as follows (IIVR, 2019; Mousumi, 2022;* Adhiyamaan, 2022*):

1. **Swarna Rekha:** This variety has been developed at HARP, Ranchi through clonal selection from germplasm of Champaran district of Bihar. It produces elongated, green-stripped, and soft seeded fruits. The yield potential of this variety is 15.0-20.0 t/ha.
2. **Swarna Alaukik:** This variety has also been developed at HARP, Ranchi through clonal selection from germplasm collected from Bhagalpur district of Bihar. It produces elongated fruits having long shelf life and is suitable for sweet preparation. Its yield potential is 20-25 t/ha.
3. **Faizabad Parwal-1:** This round and green-fruited variety has been developed through clonal selection at Narendra Dev University of Agriculture and Technology, Faizabad.
4. **Faizabad Parwal-3:** This spindle shaped and green-stripped variety has been developed through clonal selection at Narendra Dev University of Agriculture and Technology, Faizabad.
5. **Faizabad Parwal-4:** This spindle shaped and light green variety has been developed through clonal selection at Narendra Dev University of Agriculture and Technology, Faizabad.
6. **Rajendra Parwal -1:** Developed at Rajendra Agriculture University Samastipur. Bihar. Fruits are dark green with white stripes. Suitable for cultivation in Bihar & U.P. Avg, yield 150-170 q/ha.
7. **Rajendra Parwal 2:** This improved clonal selection has been developed at Rajendra Agricultural University, Bihar.
8. **Kashi Amulya (VRPG-89):** Less seeded (5-8 seed/fruit as compared to 25-30 seeds in normal variety, suitable for confectionary purpose, more fleshy, attaractive light green fruit with sparsely distributed white stripes. Yield 20-22 t/ha. Recommended for cultivation in Uttar Pradesh, vide gazette notification number S.O. 692(E), dated 05.02.2019. .
9. **Kashi Suphal (VRPG-2):** Attractive light green with mild stripes, fleshy fruit with soft seed, long duration of fruit retention in plant, better keeping quality suitable for culinary purpose and sweet making. Yield between 18-20 t/ha. Recommended for cultivation in Uttar Pradesh, vide gazette notification number S.O. 692(E), dated 05.02.2019.
10. **Kashi Alankar:** Kashi Alankar is a high yielding variety of pointed gourd developed through clonal selection at ICAR-IIVR. It is identified through State Variety Release Committee, Uttar Pradesh and release and notified by CVRC in the year 2007. Fruits are light green in colour and devoid of any white stripe with 6-7cm in length and 2-3 in diameter having an average fruit weight of 25-27g. Plants of this variety are capable of producing 120-130 fruits/vine. The average yield this variety is ranged from 180-190 quintal/ha. Recommended for release and cultivation in the states of U.P., Bihar, and Jharkhand.
11. **CHESS hybrid -1**: It is the 1st parwal variety developed in the country. Fruits are very attractive, large sized, dark green striped weighing about Avg. yield 280-300q/ha. It is adopted to upland of Bihar, U.P. Odisha, W.B. & Parts of Assam. Resistant to fly infestation.
12. **CHESS Hybrid–2:** It is a high yielding variety produced dark green stripped fruits. Avg wt. of each fruits is 25-30g. Avg yield is 300-400 q/ha.
13. **Chhota Hilli:** fruits are medium sized , oval to spindle shaped, wollen in middle. Greenish with prominent white stripped, blunt at the stalk.
14. **Dandali**: fruits medium sized, egg shaped, light green. Stalk end dispersed, slightly stripped & group towards distal end.
15. **Hilli:** Fruits are oblong , length of fruits is avg .9.6.cm & width is avg. 3 cm. Greenish fruit with white stripe, tapering towards distal end with disperse neck.
16. **Konkan Haritha**: Fruits dark green, 30-35 cm long tapering at both the ends, yields 10-12 fruits per vine.
17. **CHPG-15:** It has been identified as most promising line of pointed gourd. It is tolerant to powdery mildew &Fusarium wilt.

Varieties of pointed gourd grown in 3 states (Mousumi, 2022)

- West Bengal: Damodar, Kajli, Kajli Bombai, Kajli Damodar Chandra, Sandhamani, Hilly, Guli, Shampuria, Dhanpa, etc.
- Uttar Pradesh- Dandali, Kalyani, Guli, Bihar Sharif, etc.
- Bihar- Dandali, Nimia, Hilly, Santokhwa, etc.

PROPAGATION

Seed Propagation: Propagation through seed is undesirable due to poor germination and late flowering of sexual progeny (Singh and Whitehead, 1999; Seshadri and Parthasarathy , 2002). Seed-based popula tions produce more than 50% of nonfruiting staminate plants, where only 10% staminate plants are required for good pollination and fruit set (Maurya *et al*., 1985). Scarification using HCl or H2SO4 did not increase germination, and only 9.8% germination was obtained by culturing immature embryos (Kumar *et al*. 2008a).

Vegetative Propagation: Traditionally, *T. dioica* is multiplied through stem (Singh 1989) or root cuttings (Som *et al*., 1993; Choudhury, 1996). Ideally, the cuttings are taken from mature plants to ensure stable sex expression, fruit type, yield, and quality. Stem cuttings are planted directly or prerooted (Seshadri and Parthasarathy , 2002). In the prerooted system, cuttings of about 1.0 m long from 1-year-old plants are taken in October (when plants complete fruiting), coiled in the shape of a ring, and placed in nursery planting pits (soil is dug and filled with equal proportion of farmyard manure and soil) or in polybags filled with soil to promote rooting (Pandit *et al*., 2001). Rooted cuttings are transplanted into the open field during February and March. Alternatively, 20 cm cuttings are taken from a mature vine, planted in the nursery in October– November, and rooted cuttings are transplanted into the field in February–March. In the direct planting system, fresh cuttings of 1.0 m are placed directly in 20–30 cm deep furrows filled with organic manure and covered with moist soil, keeping 15 cm at both the ends exposed (Pandit and Hazra, 2008). Cuttings from the basal portion of vines have shown 90% success while terminal cuttings show high mortality (Dubey and Pandey, 1973). Planting of rooted vine cuttings is preferable where there is risk of frost damage during the winter. October planting allows plants to reach physiological vine maturity prior to fruit initiation, which is attained 100-110 days after planting, coincided

with the rise in temperature (i.e., February onward). Such plants flower early and give comparatively higher yields (Pandit, 1994). Between 6,000–7,000 cuttings/ha (each 60–90 cm long, having 7–10 nodes) are required in trellis systems (Singh, 1989). Nearly 5,000 cuttings are required to raise 1 ha crop on flat beds (Anon., 2005). Application of 100 mg/l 3-butyric acid (IBA) increases rooting of vine cuttings with 1 to 3 nodes (Pandey and Ram, 2000). Tuberous roots of pointed gourd are dug in early spring, subdivided (15 cm), and replanted for propagation (More and Shinde, 2003). This propagation method is easy and fast, and sprouting is generally high, but obtaining sufficient propagules is a limitation (Anon., 2005). Smaller root ''suckers'' at the nodes of vines can be used; they are uprooted in October and planted on raised beds. Stem layering is feasible but is not in general use.

Planting Method: Pointed gourd can be planted on the ground, and the vines are trained over the bowers or trellises, however, the ground culture on beds is more common. After thorough ploughings, raised beds of 15 cm height, 3 m width, and convenient length are prepared maintaining 60-75 cm spacing between two beds, which serve the irrigation cum drainage channel. Digging pits and subsequent filling with soil and farmyard manure in equal proportion prepare the mounds spaced by 60 cm on both sides of the bed at the close proximity of the channel.

The fruits are less prone to rot disease and more consumers acceptable when grown on trellis made at 60 cm height with bamboo, ropes, and wires. Mounds are prepared in the same manner. However, the planting distance is reduced to 2×0.60 m to accommodate more number of plants per unit area. Harvest span and net return from the crop can also be increased through practicing trellis system of pointed gourd cultivation (Mousumi. 2022). (Fig. 4 & 5).

Fig. 4. Bower system of planting

Fig. 5. Trellis system of planting

Triangular Staking System is of low cost as compared to other systems of planting. Harvesting is easy. Intercultural operations are easy. Quality of fruits is good as there is no rotting of fruits. Suitable for high rainfall areas. Also suitable for small and marginal farmers. Gives more than 38 % increased yield as compared to other systems (Fig. 6).

Fig. 6. Triangular staking system

Male: Female Ratio: Point gourd is a dioecious plant so the only one sex is determined in a single plant. If all plants are in the field to be found as males then the total yield would be zero. Hence maintaining the male:female ratio is very important in its cultivation. To get maximum yield in the point gourd cultivation, a female: male ration of 9:1 should be maintained (Jagdish, 2019).

HARVESTING AND YIELD

Generally, vines start fruiting about 5 months after transplanting (Anon., 2005), typically in February and continuing through September. Seedlings, however, usually begin fruiting 143–316 days after transplanting (Kumar *et al*., 2008a). Fruits are harvested about 15 days after pollination before physiological maturity; fully mature fruits are un- marketable. Harvesting is generally done at weekly intervals, and fruits can be stored at ambient temperatures (28◦–30◦C) for about 3 days. Harvesting, generally, starts 90-100 days after planting. In October planted crop of Gangetic alluvial zone of West Bengal, harvesting of fruits, generally, starts from middle of February and continues up to July at frequent intervals and up to September if new flushes come with the monsoon rains. Harvesting should be done frequently when the fruits are immature, tender with soft seeds inside and 7 to 15 days' fruit after flowering depending on cultivars are ideal for both quality and yield. Delay in harvesting reduces further fruiting capacity of the vine. The plants produce maximum yield for 3-4 years. Harvesting at weekly intervals gives more yield (Mousumi, 2022). Young immature pointed gourds are the most effective for cooking: the skin is bright green colored, the flesh inside is white, and also the seeds are small and tender. Don't use mature pointed gourds since they are usually less flavorful. The fully ripe fruit turns orange and mushy, is too sweet to consume (HBT, 2022). Generally yield depends on the crop management, variety cultivated and plant population. In the parwal cultivation an average yield of 15 to 20 tonnes per hectare can be achieved (Jagdish, 2019).× Yield and quality generally depend on plant population and prevailing weather conditions during the fruiting period. In 3.0 x 0.75 cm spacing accommodating approximately 9,000 plants per hectare the yield ranges from 130 to 170 t/ha in different clones under lower Gangetic

plains (Pandit, 1994). Ratoon crops, if managed well, give a higher yield compared to that of the first year (Pandit and Hazra, 2008; Mousumi, 2022).

USES

Culinary Uses (HBT, 2022)

Especially in India and Indonesia, Pointed Gourd can be considered as one of the essential vegetables for cooking. It forms a staple of many dishes in these countries, and even in other parts of Asia. It is used as an ingredient for soup, stew, curry, sweet, or eaten fried and as potoler dorma or dolma (dolma) with fish, roe or meat stuffing. Parwal can also be pickled in vinegar with an assortment of herbs and spices, as a side dish or a salad. Parwal can be stuffed, or cut into cubes and sautéed, or made into soups. Parwal is cooked with potatoes, and served with yogurt or in a vegetable dish known as subzis in West Indies. Parwal soup is traditionally prepared for sick people in Nepal. Pointed gourd is prepared in various dishes, such as stir fry, cooked in coconut milk, or steamed in Indonesia. The tender fruits of pointed gourd are, generally, consumed as cooked and fried vegetable dishes, and also used in making curries and preparing pickles. Keeping the fruits filled with milk cake in sugar syrup a famous sweet is prepared in India. The newly emerged tender shoots with leaves are also a preferred potherb in many households in India (Adhiyamaan, 2022; Mousumi, 2022). There is a popular belief that leaves of pointed gourd are a preventive antidote of bile disorders and worms. The easily digestible tender fruit helps in proper renal functions and prevents constipation. It invigorates the heart and brain, and is significantly effective in several circulatory disorders (Mousumi, 2022).

Traditional uses and benefits of Pointed Gourd (HBT, 2022)

- It is used to treat digestive disorders, skin conditions and fevers.
- An extract is made of the gourd's seeds and used to lower cholesterol and blood sugar levels.
- It is useful in gastro intestinal and liver disorders.
- It is used in jaundice, viral infections, and skin diseases.
- It helps in throwing out worms from the stomach and cures constipation.
- It gives one with strength and sexual powers.
- It also cures cough, eczema, blood-impurities, excessive phlegm and flatulence.
- Make juice of seeds of pointed gourd mixing it with a few powder of Hing and take it that is considered to be excellent assist in losing fatness.
- Consuming juice of pointed gourd also energized you.
- The leaves juice of plant is very effective in treatment of febrifuge, edema, alopecia and in sub-acute cases of enlargement of liver.
- Cooked parwal is helpful in improving appetite and digestion.
- Leaves are used in treatment of enlarged liver and spleen, hemorrhoids, fevers, leprosy, intrinsic hemorrhage, erysipelas, alopecia, diseases of mouth, inflammations and wounds.
- Juice of leaves is applied on scalp for 21 days to treat baldness.
- In case of excess cough, decoction of leaves is beneficial. It is prepared by boiling Parwal leaves 6g and dry ginger powder in one glass water for few minutes. This is filtered and taken twice a day.
- Leaves of plant are boiled in water and this decoction is taken internally for hyper acidity and biliousness.
- Paste of leaves is applied topically for boils, wounds.
- Parwal leaves juice should be taken in dose of 5-10 ml with honey for raktpitta (variety of bleeding disorder that occurs due to excessive use of food which has hot, acidic potency).
- Decoction of tender shoots with sugar improves digestion.
- Leaf juice is rubbed over the chest in liver congestion and over the whole body in intermittent fevers.
- Fresh juice of the unripe fruit is often used as a cooling and laxative adjunct to some alterative medicines.
- Fruit is used as a remedy for spermatorrhoea.
- Decoction of patola leaves and coriander in equal parts is given for bilious fever.
- Fruit in combination with other drugs is recommended in snakebite and scorpion sting.

NUTRITIONAL VALUE OF FRUITS

Nutritional Value: Pointed gourd has higher nutrient content than other cucurbits (Pandit and Hazra, 2008). Its fruits are rich in vitamin A (153 mg/100 g), and protein levels are 10 times higher than that of bottle gourd and 4 times that of snake gourd, ridge gourd, and ash gourd. According to Choudhury (1996), 100 g (fresh weight) of edible fruits contains P (40 mg), Ca (30 mg), Mg (9 mg), Na (2.6 mg), K (83 mg), Cu (1.1 mg), S (17 mg), and Cl (4 mg) and also provides 20 kcal energy (Seshadri, 1990). Every 100 g of fresh leaves contains 5.4 mg proteins, 4.2 mg fiber, 531 mg Ca, and 73 mg P (Gopalan *et al*., 1989) and also provides 55 kcal energy (Seshadri, 1990). In addition, seed extract possesses hemagglutination activity that may have some diagnostic applications. Hemagglutination is a reaction that causes clumping of red blood cells in presence of some enveloped viruses, such as the influenza virus (Sathe *et al*., 1967).

Pointed gourd is known as the king of gourds because of having higher nutrient contents than other cucurbits. Protein content of pointed gourd is 10 times that of bottle gourd and 4 times that of snake gourd, ridge gourd, and wax gourd. Similarly, pro-vitamin A and vitamin C content is higher than many other cucurbits. The protein, mineral, fibre and calcium contents of pointed gourd leaves are the highest (5.4 g, 3.0 g, 4.2 g and 531 mg per 100 g of edible portion, respectively) among all the cucurbits, and it also provides high energy of about 55 kilocalories. The nutritional composition of pointed gourd fruits is given below in Table 1 ((Mousumi, 2022). Pointed gourd is a good source of vitamins and minerals. It is a good source of carbohydrates, vitamin A, and vitamin C.

Table 1. Nutritional value of pointed gourd fruit (100 g edible portion)

Constituents	*Contents*	*Constituents*	*Contents*
Water (g)	92.0	Iron (mg)	1.7
Dietary fibers (g)	3.0	Phosphorus (mg)	40.0
Protein (g)	2.0	Potassium (mg)	83.0
Fat (g)	0.3	Vitamin A (IU)	255.0
Carbohydrates (g)	2.2	Thiamine (mg)	0.05
Minerals (g)	0.5	Riboflavin (mg)	0.06
Calcium (mg)	30.0	Niacin (mg)	0.5
Magnesium (mg)	9.0	Ascorbic acid (mg)	29.0

It also contains major nutrients and trace elements (magnesium, potassium, copper, sulfur, and chlorine) which are needed in small quantities, for playing essential roles in human physiology. 9.0 mg Mg, 2.6 mg Na, 83.0 mg K, 1.1 mg Cu and 17 mg S per 100 g edible part (WIKI, 2022). The vegetable is rated as one of the nutritious foods and is offering vitamins like vitamin A, vitamin B1, vitamin B2 and vitamin C (HBT, 2022).

HEALTH BENEFITS

In the traditional Ayurvedic system of medicine, T. dioica fruits have been described to possess antihelminthic, antipyretic, diuretic, appetizing, digestive, expectorant, and antirheumatic effects (Sharma and Pant, 1988a; Seshadri, 1990). Leaves and tuberous roots of pointed gourd are also used in Ayruvedic medicine (Chandrasekar *et al*., 1989). Aqueous extracts of *T. dioica* leaves were reported to have a hypoglycemic effect in healthy rats and an antidiabetic effect in a strepto zoicin induced diabetic rat model (Rai *et al*., 2008a). Seeds of *T. dioica* have been reported to possess antibacterial as well as antifungal activities and are used in acid dyspeptic disease treatment (Harit and Rathee, 1996). Pointed gourd roots have a strong purgative action, while the unripe fruits and tender shoots (typically consumed in curries) act as a laxative (Rahman *et al*., 2008).

The claims that *T. dioica* fruits lower total serum cholesterol and blood sugar have been supported by results from experiments with rats (Chandrasekar *et al*., 1988, 1989; Rai *et al*., 2008b) and rabbits (Sharma and Pant, 1988a,b,c). Similar results were obtained in case of mild diabetic human subjects (Sharma *et al*., 1990). Banu *et al*. (2007) reported a similar trend with oral administration of aqueous fruit extract (50 ml/kg body weight) to normal and diabetic rats. Recently, Ghaisas *et al*. (2008) reported the hepato protective properties of aqueous and ethanolic plant extracts of *T. dioica* in rats, which was attributed to antioxidants similar to those reported for carotene, saponins, tannins, and vitamin C. Mature plants and seeds of *T. dioica* contain abundant amounts of common triterpenes, such as a- and b-amyrins, and cycloartenol (Akihisa *et al*., 1988). A galactose-specific lectin from seed extracts of *T. dioica* was isolated using affinity chromatography on cross-linked guar gum (galactomannan) (Sultan *et al*., 2004). A highly thermostable lectin from *T. dioica*, which remained active up to 90oC and over a wide pH range (6–12), has been isolated; its structure and stability indicated that it was similar to type II ribosome-inactivating proteins (Dharkar *et al*. 2006; Kavitha and Swamy 2009).

Pointed gourd is rich in vitamin c, vitamin a and carbohydrates. It is also rich in vitamins and minerals. It is used as as ingredient in soup, stew, curry, sweet or eaten fried with vegetarian and non-vegetarian item. This gourd is very famous in Bangladesh and it is consumed in every part of Bangladesh. Pointed gourd improves digestion, treats constipation, controls blood cholesterol and sugar, aids weight loss, acts as blood purifier, reduces flu, has anti-aging properties (Vegetables Info, 2015). This vegetable has many healing properties ranging from the ability to prevent and cure colds to curing jaundice of the liver. At the same time it is a rich source of many micronutrients, such as like vitamins A, B1, B2 and C and also calcium. On the other hand Pointed Gourd is rich in fiber and low in calories which help in reducing and maintaining weight. Even a small amount of this vegetable provides a lot of nutrients needed by the body and that too with very less calories. At the same time, Pointed Gourd also effective in controlling serious ailments like diabetes and high cholesterol. Not only does ayurveda consider pointed gourd to be a tonic for the heart it is also used in the treatment of various ailments, such as skin infections and constipation etc. Apart from being anti-viral it. Pointed Gourd is also anti-bacterial in nature and hence can be used to treat many different forms of infections. Slowly the western world is realizing the benefits of this vegetable and it is finding its way to western kitchens as well (Lybrate, 2020). Pointed gourd also offers you very less calories and hence it helps to keep the cholesterol levels in control. In Ayurveda, pointed gourd is used to treat the gastric problems and is also used as a natural aphrodisiac that can improve sex life (HBT, 2022).

Below are some of the health benefits and medicinal value of the pointed gourd: 1) The pointed gourd is a good source of vitamns. 2) Pointed gourd helps in improving digedtion. 3) Pointed gourd controls blood sugar levels. 4) Pointed gourd controls the cholesterol level and keeps the heart-healthy. 5) Pointed gourd helps in treating constipation. 6) Pointed gourd helps in weight loss program. 7) The pointed gourd is a blood purifier. 8) Pointed gourd helps in reducing flu symptoms. 9) Pointed gourd fights with aging (Jagdish, 2019). Mentioned below are the best health benefits of Pointed Gourd (Lybrate, 2020; HBT, 2022):

***Improves digestion*:** Pointed gourd is a vegetable that has a high content of fiber, which enhances the digestive health. Pointed gourd also helps in treating some liver ailments and problems associated with the digestive system. If your digestive system is able to digest food properly, it will remain clear and in turn improve your overall health.

Treats constipation problem: Constipation is not as simple as we consider it to be because chronic constipation, if untreated, can lead to various serious health problems. This is because the waste food remains sitting in the intestines and can cause different ailments. Constipation can occur due to less intake of water or due to high intake of minerals like iron. The seeds in bitter pointed gourd prevent to ease the passage of stools and this why this veggie is recommended for people who suffer from constipation.

Controls blood sugar: If you are preparing a dish from pointed gourd you should not throw away the seeds because they help in controlling blood sugar levels. Diabetes is a lifestyle disease and can also be caused due to hereditary factors. However, you can control the blood sugar levels by including parwal in good amounts in your diet.

Helps in weight loss: Obesity has become a major problem all over the world due to the sedentary lifestyles and reliance on junk food which has lot of fat. However, obesity should not be taken lightly as it can lead to severe ailments like heart disease, hypertension etc. As mentioned above pointed gourd is a low calorie food and is high in fiber. This means that it makes you feel full without consuming too many calories. This is the reason that people who are trying to lose weight should eat this vegetable as much as they can

Acts as blood purifier: Pointed gourd also purifies the blood according to Ayurveda, which says that pointed gourd is very good at controlling the kapha in the body. Hence people, who are suffering from an imbalance of kapha in their body, can be benefited by eating pointed gourd. Purification of blood is important in order to keep the body free of many serious ailments.

Lowers blood cholesterol levels: As mentioned above the seeds of pointed gourd are effective in controlling blood sugar levels. At the same time they are also good at controlling the cholesterol levels. Pointed gourd reduce the levels of bad cholesterol LDL and enhance the levels of good cholesterol HDL.

Treats flu: Cold and flu are common ailments and although they are not usually serious, can make you feel miserable and uncomfortable. According to Ayurveda, pointed gourd has the ability to boost your immunity and make you less susceptible to viral infections which cause cold and flu. This action is due to the presence of high amounts of vitamin C in pointed gourd vegetable. It also can be used as a medicine to treat flu, high fevers and throat irritation.

Reduces the signs of ageing: Pointed gourd is rich in antioxidants, vitamins A and C and hence helps to reduce the signs of aging on the skin. However, its benefits are not just limited to the skin, but it prevents the premature aging of all organs in the body.

Helps in treating jaundice: As mentioned above pointed gourd is good for the liver and hence helps in the treatment of jaundice which is an ailment affecting the liver. At the same time it also improves the overall functionality of the liver. This in turn improves digestion because the liver plays an important part in the digestive system.

Used for treating alcoholism: According to the ancient Indian text the *Charaka Samhita* it is also used in the treatment of alcoholism. Not only the fruit but also the leaves of the pointed gourd plant are useful for this purpose.

***Has antibacterial properties*:** The leaves fruits and seeds of pointed gourd are used as antibacterial agents. This is the reason that the various parts of the plant are used in treating bacterial infections of different kinds.

Used for treating anorexia: Anorexia is a psycho-physical ailment and modern research has proved that pointed gourd is excellent in the treatment of anorexia.

Ayurvedic Health Benefits (HBT, 2022)

Because of the Ayurvedic health benefits of Pointed Gourd, it is now manufactured in supplement form and other health teas and drinks by companies providing supplements, such as Tranquility Labs. This is

an advantage for us since we now have the opportunity to purchase these products in the form that we best wish to take it in – in case the fruit itself is not available in our region.

- **Headache:** Crush the roots of pointed gourd and make paste and apply it on your forehead and let it dry.
- **Wounds:** Prepare root decoction of pointed gourd and use it to wash your wounds.
- **Alopecia Areata:** Crush leaves of pointed gourd to make paste and apply over bald patches. Wash when it dries.
- **Liver disease:** Take 2 tsp leaf juice of pointed gourd once a day.
- **Blood Purifier:** Consume 20 ml pointed gourd juice thrice a week, it is beneficial for blood.
- **Cough:** Make a root decoction of pointed gourd and drink 5 ml twice a day.
- **Skin diseases:** Take a 1 tsp leaf juice of pointed gourd and add same amount of honey in it and take it with warm water.

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