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Short Communication

Hybridization for increased yield and nutritional content of snake melon (*Cucumis melo* L. var. *flexuosus*)

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Abstract

This is the first report on increasing yield and nutritional content of snake melon (*Cucumis melo* L. var. *flexuosus*) by exploiting intraspecific genetic variation of genetically diverse melons. Inbred snake melon 'Punjab Long melon 1' (PLM1) was hybridized with five genetically diverse inbred melons: KP 7 (var. *momordica*), AM 72 (var. *acidulus*), 'Arya 1' (var. *chate*), 04-02 (var. *tibish*) and 'Punjab Wanga' (unknown botanical variety). The parents and hybrids were evaluated at three locations for nine traits. Hybrids PLM1 × 04-02 and PLM1 × 'Punjab Wanga' exhibited significant ($P_{0.05}$) heterosis for the number of marketable fruits per plant, and ascorbic acid and carotenoid contents of marketable fruits.

Keywords: heterosis; intraspecific diversity; landrace; leafminer resistance

Introduction

Snake melon (*Cucumis melo* L. var. *flexuosus*; $2n = 2x = 24$) is an important cucurbit crop in India, commonly known as 'Kakri' or 'Tar'. The fruits of this non-dessert melon are long and slender in shape and are available in three colours: yellow-green, light green and dark green, and they have furrowed or wrinkled exterior surfaces; young fruits are eaten fresh in salad. The open-pollinated cultivars 'Punjab Long melon 1' (PLM1) and 'Arka Sheetal' are grown in India. High-yielding F_1 hybrid snake melon cultivars have not entered the market. This can be attributed to low genetic diversity available among snake melons in India (Sheshadri and More, 2002). Other non-dessert types of melon eaten in salad in India are snapmelon (var. *momordica*), 'Vellari' (var. *acidulus*), 'Arya' (var. *chate*) and 'Wanga' (unknown botanical variety). In Sudan, Tibish melon (var. *tibish*) is eaten raw in salad (Mohamed and Pitrat, 1999). Our objective was to determine the potential for increasing fruit yield and quality parameters of snake melon through intraspecific crosses of snake melon with representatives of the genetically diverse melon groups (Pitrat *et al.*, 2000).

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Table 1. Fruit traits and ascorbic acid and carotenoid contents of the parents and their hybrids, Varanasi, Uttar Pradesh, India, 2008

Parent/cross	No. of marketable fruits per vine	Fruit length (cm)	Fruit width (cm)	Days to marketable fruit maturity[a]	Dry matter of marketable fruit (%)	Ascorbic acid (mg/100 g fruit flesh)	Carotenoids (μg/100 g fruit flesh)
PLM1 (P1)	4.7	22.3	2.4	8.2	6.4	6.6	2170
Punjab Wanga (P2)	5.6	7.7	2.8	9.2	5.0	8.3	540
04-02 (P3)	4.1	9.4	3.2	8.8	6.5	11.6	480
AM 72 (P4)	3.5	22.3	11.5	8.2	6.1	1.6	140
KP 7 (P5)	7.7	7.4	3.7	9.2	5.2	14.9	1660
Arya 1 (P6)	6.1	10.8	4.1	7.8	6.1	8.3	580
P1 × P2	14.3	18.9	3.1	7.8	6.3	9.1	1350
P1 × P3	15.2	20.8	2.8	6.9	6.2	9.1	3720
P1 × P4	5.3	11.3	3.7	10.2	6.1	11.6	720
P1 × P5	9.6	10.9	3.2	8.0	6.1	8.3	780
P1 × P6	11.2	18.4	2.4	10.6	5.5	8.3	4470
LSD (0.05)	1.8	1.9	0.5	1.2	1.1	3.1	60
Heterosis[b] (%) (P1 × P2)	205	−15.2	29.2	−5.0	−1.5	37.8	−83.9
Heterosis[b] (%) (P1 × P3)	224	−6.7	16.7	−16.1	−3.7	37.8	71.4

LSD, least significant difference.
[a] Days taken to harvest fruits after anthesis.
[b] Heterosis values over the commercial PLM1 (P1).

Table 2. Fe and Zn contents and qualitative fruit traits of the parents and their hybrids, Varanasi, Uttar Pradesh, India, 2008

Parent/cross	Fe (mg/100 g fruit flesh)	Zn (mg/100 g fruit flesh)	Fruit skin colour[a]	Fruit flesh colour[a]	Fruit texture	Fruit taste	Consumer preference
PLM1 (P1)	1.12	0.27	Yellow-green 145a	Yellow-green 142c	Crisp	Non-bitter	Good
Punjab Wanga (P2)	1.27	0.16	Green 134b	Green 142b	Crisp	Non-bitter	Poor
04-02 (P3)	1.10	0.17	Green 137c	Green 142c	Crisp	Non-bitter	Poor
AM 72 (P4)	–	–	Green 135c	Yellow 8d	Crisp	Non-bitter	Poor
KP 7 (P5)	1.26	0.25	Green 137d	Green 142c	Crisp	Non-bitter	Poor
Arya 1 (P6)	1.08	0.24	Green 137b	Green 142c	Crisp	Non-bitter	Poor
P1 × P2	1.05	0.18	Green 134c	Yellow-green 142c	Crisp	Non-bitter	Good
P1 × P3	1.14	0.22	Green 142c	Yellow-green 145b	Crisp	Non-bitter	Good
P1 × P4	0.86	0.14	Yellow-green 147a	Yellow-green 145c	Crisp	Non-bitter	Poor
P1 × P5	1.49	0.15	Green 135c	Yellow-green 145c	Crisp	Non-bitter	Poor
P1 × P6	1.36	0.30	Yellow-green147c	Yellow-green 40d	Crisp	Non-bitter	Good
LSD (0.05)	0.28	0.15					
Heterosis[b] (%) (P1 × P2)	−6.1	−33.3					
Heterosis[b] (%) (P1 × P3)	1.8	−18.5					

LSD, least significant difference.
[a] Royal Horticultural Society Colour Chart was used for the identification of fruit skin and flesh colours.
[b] Heterosis values over the commercial PLM1 (P1).

Experimental

The highly inbred snake melon (var. *flexuosus*) 'PLM1' was crossed with five highly inbred landraces of melon: KP 7 (var. *momordica*), AM 72 (var. *acidulus*), 'Arya 1' (var. *chate*), 04-02 (var. *tibish*) and 'Punjab Wanga' (unknown botanical variety).

Evaluation of morphology and productivity of the breeding material was carried out in spring 2008 at the Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh, India. The six parents and their five F_1 hybrids were sown in compost, and were transplanted to the field at the three-leaf stage of growth. Each of the three replications containing ten plants was arranged in a randomized complete block design with a row spacing of 3 m and within a row spacing of 0.45 m. Plants were furrow irrigated and fertilized and protected against pathogens and pests according to standard horticultural practices. Five central plants of each entry were used for taking observations. The following traits were recorded: (1) days to marketable fruit maturity, (2) marketable fruit number per vine, (3) fruit length (cm), (4) fruit width (cm), (5) fruit skin colour, (6) fruit flesh colour, (7) fruit taste, (8) fruit texture and (9) consumer preference of fruit traits. The fruit skin and flesh colours were measured using the Royal Horticultural Society Colour Chart. Consumer preference was determined by a panel of eight trained judges who evaluated the following fruit qualities: shape, size, skin colour, flesh colour, taste and texture. The panel consisted of scientists (2), undergraduate students (2) and housewives (4); all were familiar with the crop. Taste (bitter/non-bitter) and texture (soft/crisp) were judged by eating marketable fruit. A nine-point hedonic scale test was used for measuring consumer preference (Amerine *et al.*, 1965).

Hybrids PLM1 × 04-02 and PLM1 × 'Punjab Wanga' exhibited superior horticultural performance at Varanasi, and were evaluated in 2009 at Ludhiana, Punjab, and at Pasighat, Arunachal Pradesh, for marketable fruits per vine, fruit length and fruit width. Five young (10 d post anthesis) fruits of each entry in each replication were harvested for biochemical assays. Ascorbic acid was bioassayed as described by Bajaj and Kaur (1981). Total carotenoids were estimated by the method described by Thomas and Joshi (1977). Fe and Zn were measured in diacid digest of fruit samples with an atomic absorption spectrometer (Varian AA 20).

Results and discussion

The values of the various horticultural traits of the best performing F_1 hybrids and their parents at Varanasi are given in Tables 1 and 2. Hybrids PLM1 × 04-02 and PLM1 × 'Punjab Wanga' exhibited high values of heterosis over PLM1 for the number of marketable fruits per plant (224 and 205%, respectively) and days to marketable fruit maturity (−16 and −5.0%, respectively). High heterosis (71.4%) over PLM1 for fruit carotenoids was observed in the hybrid PLM1 × 04-02, while both hybrids exhibited less heterosis for the ascorbic acid content of fruit (37.8%). Fe and Zn contents of these two hybrids were 1.14 mg/100 g and 1.05 mg/100 g of marketable fruit weight and 0.22 mg/100 g and 0.18 mg/100 g of marketable fruit weight, respectively (Table 2). Heterosis for these traits was not observed. Both hybrids had high consumer preference ratings (Table 2). Both hybrids had elongated wrinkled fruits (19–21 cm long and 2.8–3.1 cm wide), which were crisp and non-bitter with green skin and yellow-green flesh.

During field evaluation in the trial conducted in Punjab, PLM1 × 04-02 as well as 04-02 was observed to be resistant to leafminer [*Liriomyza trifolii* (Burgess)]. Other Tibish accessions have been found to possess resistance to this insect (El Tahir and Taha Yousif, 2004). Dominant resistance to leafminer was reported in Nantais Oblong (var. *cantalupensis*; Dogimont *et al.*, 1999).

Snake melon is very popular among the travellers in India especially during the summer as its consumption helps to quench the thirst. The marketable fruits of the two hybrids possessed moisture (94%) similar to that available in PLM1 (Table 1). The two hybrids performed similarly at another warm, dry location in the Punjab state of northern India. At this location, PLM1 × 04-02 and PLM1 × 'Punjab Wanga' yielded 16.7 and 15.5 marketable fruits per vine, respectively, and these two hybrids had a high consumer preference rating. Fruit length (20.4 and 19.5 cm) and breadth (3.1 and 3.2 cm) were also similar to those observed in the trial conducted at Varanasi. The two hybrids did not have a yield advantage in a trial conducted in the humid tropics (high rainfall) of Arunachal Pradesh, an eastern state of India (data not presented), probably because of high incidence of powdery mildew [*Podosphaera xanthii* (Castagne) Braun and Shishkoff] and downy mildew [*Pseudoperonospora cubensis* (Berk et Curtis) Rostovzev]. More multi-location testing of these two hybrids is required.

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