Yield and Quality of the Interspecific Cross *Cucurbita argyrosperma* x *C. moschata*

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Introduction: In northwest Mexico, the mature fruit quality of *Cucurbita argyrosperma* Huber (ARG) fruits is lower than other winter squashes such as Kabocha and 'Waltham Butternut' (Waltham) (1,5,8). Merrick (7) found, working with landraces from northwest México, that fruit flesh color varies from pale to deep orange. She also found that there is high genetic compatibility between ARG and *C. moschata* (MOS). Wessel-Beaver et al (9) reported that desirable traits could be transferred between these two species, for example, using MOS to improve the sugar and carotene content in ARG. Interspecific, commercial F_1 hybrids within this genus such as 'Tetsukabuto' (*C. maxima* □ *C. moschata*) that are cultivated nowadays, have high yield and good quality and are also used as rootstocks for grafting melons. They are grown in fungi-infested soils and are useful in reducing applications of soil fumigants (3). The objective of this work was to study crosses of ARG x MOS in order to find out whether desirable traits such as high soluble solids content (SSC), intense orange flesh color and thus high carotenoid content, could be introduced to our ARG material. We also wanted to explore whether F_1 hybrids of acceptable quality could be obtained for commercial growing by crossing these species.

Materials and Methods: ARG (A-43, A-52, and A-71), six MOS breeding lines, and Waltham, were grown during the summer-fall season of 2005. Seventy-four crosses were performed from October 7 to 21 using ARG as the female parent. Forty-five fruits were picked on December 5 and seeds extracted from December 15 to 23. The number of sound (at least half-filled) seeds per fruit of hybrids and their female parent were counted and weighed. F_1 hybrids and male and female parents were established by direct seeding in August 18 and 19 of 2006 and selfing of hybrids and backcrossing to ARG was performed. However, it was noticed early during fruit development that all of the hybrids obtained using the six MOS breeding lines mentioned above as male parents had bitter fruits. Thus, they were discarded after fruit maturity. Bitterness was reported in F_1 individuals from ARG × *C. pepo* crosses (2). Selfed fruits from hybrids A-52 × Waltham and A-71 × Waltham were non-bitter and their seeds were saved. Also, seeds from backcrosses to ARG using these hybrids were obtained and then were direct-seeded along with parents on August 15, 2007. The accessions tested are listed in Table 1. Fruits were picked 51 days after flowering and a sample of 6 fruits was taken at random, weighed, and analyzed two days after harvest for SSC and flesh color. SSC was determined in fruit juice using an ABBE Leica Mark II refractometer model 10459 and flesh color was determined with a portable Minolta CR-300 tristimulus colorimeter.

Additional ARG × MOS crosses for F_1 seed were performed during the summer-fall season

of 2006 using ARG breeding lines A-30 and A-22 and the landrace San Pedro Ho:l purchased at Search Seeds, Tucson, AZ. Waltham was also used as pollinator. The ARG breeding lines have an elongated fruit shape similar to Waltham but have larger fruit and have an obviously inferior fruit quality in comparison to Waltham. The landrace produced mostly elongated fruits (used for pollination) but also pear and round shape fruit in lower proportion. Fruits were picked 47 days after flowering and analyzed 36 days after harvest. Fruit weight of the F_1 hybrids was recorded using a 10 kg balance, SSC was measured with an Atago hand refractometer, and flesh color was measured with a portable ColorTec PCM colorimeter. Seven randomly selected fruits were used for statistical analysis. Analyses of variance of data for fruit characteristics for both experiments were done as completely randomized designs and Duncan´s multiple range test was used for mean separations using the NCSS (Number Cruncher Statistical Systems) 2000 program.

Results and Discussion. Fruit set from the ARG × MOS pollinations performed in 2005 was 61% and the average number of F_1 seeds per fruit was 127 (1-402). Seeds had a weight per fruit of 19.4 g (0.2-75) (Results not shown). In comparison, the female parents had an average of 294 open-pollinated seeds per fruit (50-410) with a weight per fruit of 55.4 g (11.5-79.5). Merrick (7) obtained 55% fruit set from 13 ARG × MOS crosses and an average of 82 seeds per fruit while Wessel-Beaver et al., (9) reported 41% fruit set in 24 pollinations and acceptable seed formation. Table 1 shows the results for SSC and flesh color measured two days after harvest for lines A-52 and A-71 and crosses with Waltham. While fruit weight had a significant increase when compared with Waltham, SSC and flesh color did not. However, in a group of fruits from both F_2 populations that were self-pollinated and de-seeded 42 days after harvest (data not statistically analyzed), there were single SSC readings of 13.0 and 13.5% for two selections of A-71 × Waltham F_2 while Waltham had 13.0%. High readings for flesh color as well (analyzed with the ColorTec PCM colorimeter) were observed in a few fruits for the A-52 × Waltham F_2 (8410 and 8060) while Waltham had a score of 8470. Five fruits from A-71 × Waltham F_2 also had scores higher than 8020. Fruits with acceptable color usually had values higher than 7500. Scores for fruits of lines A-71 and A-52 were 6730 (pale yellow) and 6320 (almost white), respectively. It is well known that the sugar and carotene content increase in winter squash after harvest (1,6). The SSC of an ARG breeding line increased from 7% at harvest to 10% at 56 days after harvest, and then decreased significantly by 98 days after harvest (5).

Table 2 shows results for fruit weight, SSC, and flesh color measured 36 days after harvest for F_1 hybrids obtained in 2006. The SSC of Waltham reached 12.8% and was similar only in the hybrid A-22 × Waltham. Waltham had also a high score for flesh color and two hybrids, San Pedro × Waltham and A-22 □ Waltham were within the same group of significance. An estimate of yield was done considering the average fruit number and fruit weight. Line A-30 had a yield of 44.1 ton.ha^{-1} while Waltham produced 10.6 ton.ha^{-1}. Hybrids A-30 × Waltham, San Pedro × Waltham, and A-22 × Waltham had yields of 40.1, 23.4, and 23.3 ton ha^{-1} respectively. Intraspecific F_1 hybrids obtained using MOS breeding lines crossed with Waltham had larger fruits than Waltham but had lower yields than the female breeding lines (4).

Even though at harvest time *C. argyrosperma* × *C. moschata* fruits taken from small samples had low SSC and flesh color, single fruits from the F_2 generation from larger samples analyzed

several weeks after harvest may have quality comparable to an improved cultivar of winter squash. Therefore, it seems possible to develop *C. argyrosperma* cultivars with better fruit quality. It is also concluded that is possible to grow F_1 hybrids from this cross.

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Table 1. Fruit weight, soluble solids content (SSC), and flesh color (b or yellow color) of interspecific crosses of *Cucurbita argyrosperma* *C. moschata*

Plant material	Weight (kg)	SSC (%)	Flesh color (b)
A-52	2.0 b	5.6 b	60.8 b
A-52×W F_1	1.9 b	7.5 b	60.4 bc
A-52×W F_2	1.2 c	5.2 b	55.9 c
A-52× (A-52xW) R_1	1.6 bc	5.6 b	57.7 bc
Waltham (W)	1.0 c	10.2 a	72.3 a
A-71	2.5 a	6.9 b	44.2 c
A-71×W F_2	1.5 bc	5.9 bc	53.8 b
A-71× (A-71xW) R_1	1.4 bc	4.5 c	41.0c

Means within a column not followed by the same letter are significantly different (P<0.05).

Table 2. Fruit weight, soluble solids content (SSC), and flesh color according to colorimeter yellow index observed 36 days after harvest from interspecific crosses of *Cucurbita argyrosperma* *C. moschata* and parents.

Plant material	Weight (kg)	SSC (%)	Y (yellowness)
Waltham (W)	0.9 c	12.8 a	8366 a
A-22	2.2 b	8.3 cd	5897 c
A-30	3.6 a	8.0 cd	6694 b
San Pedro Ho:l	2.2 b	6.6 d	6529 bc
A-22 × W	1.9 b	11.5 ab	7810 a
A-30 × W	3.0 ab	7.6 cd	7164 b
San Pedro × W	2.4 b	9.8 bc	8069 a

Means within a column not followed by the same letter are significantly different (P<0.05).