Pitahayas: introduction, agrotechniques and breeding

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Geographic distribution

*Hylocereus* species

Known as Pitahayas, Vine cacti, Dragon fruits

Species native to Central and South America

- Mexico
- Costa Rica
- Panama
- Colombia
- Venezuela
- Etc.
Plant characteristics

Fruit with scales (few of them with spiny peel)

Triangular stem

Wax in few species

Climbing plants, roots can be detached from soil

Spine shape
Nocturnal flowers
Open only one night – receptive 1 day
Bat feeding on nectar and pollinating

Pollination by bees

Not in Israel!!
Genetic variability
Why Pitahayas as a fruit crop?

1. Water use efficiency (WUE) - one order of magnitude higher than other crops (CAM plants)

2. Many uses: food (exotic and beautiful fruits), industrial, ornamental products and more

3. Exotic fruit in world markets – high value crop
Agrotechniques

1- Manual pollination due to self-incompatibility and lack of natural pollinators
2- Acclimation to arid and semi-arid conditions
3- Trellising climbing plants
4- Mechanization for removing spiny peel from yellow pitahaya

Others issues to solve:
Irrigation, fertilization, pruning, short shelf-live
Hand-cross pollination
Orchard establishment:
1- Net
2- Trellis

Shade net density - depends on local radiation intensity
Heat damage, 90% yield reduction

Chilling injury 4-5 °C
Nematode damage

Excellent start, good yield and fruit size.

Destroyed the plants in years 4 & 5.
Possible problems with the de-spining machine
Red pitahaya orchard: 35 ton/ha

Yellow pitahaya orchard: 15 ton/ha
not profitable
First introductions

✓ **Hylocereus spp.**: “red pitahaya” large and attractive fruit but lack taste, ripens in summer

✓ **Hylocereus megalanthsus**: “yellow pitahaya” delicious but spiny peel, fruit inferior in size and yield, ripens in winter
Breeding program

Goals: taste, size, yield, spineless, self-compatible, prolonged shelf-life

- *Hylocereus* spp.: “red pitahaya” - diploid species
- *H. megalanlthus*: “yellow pitahaya” - tetraploid
Breeding and selection

- Recombine parents
- Select parents
- Grow out progeny
- Evaluate progeny

Long and arduous process
Red pitahaya hybrids - one day in the lab!

Large variability in almost every aspect!

Improved “summer” hybrids
Red-yellow pitahaya hybrids (F1)

Red pitahaya
Female parent

Yellow pitahaya
Male parent

F1 = triploid

Excellent in taste but spiny peel and low yields – “Autumn” cultivars

S-75

12-31

12-16
New orchards with F$_1$ hybrids

“Autumn” cultivars
triploids

“Summer” cultivars
diploids

Yields: 25-35 ton/ha

500-1,000 m$^3$ water/ha/year

(about 10,000 m$^3$ water/ha/year for other fruit crops)
Second generation of F₂ hybrids

Preliminary evaluation

Fruit morphology in hybrids
Other breeding projects

1. “in situ” polyploid induction

2. Production of homozygous Haploid-DH lines

3. Embryo rescue following interspecific-interploidy crosses
“in situ” polyploid induction

The goal: obtain artificial red and yellow polyploid plants

Treatments:

a- Vegetative lateral bud

b- Germinating seed
Red pitahaya  2n →  4n

1- Bigger flower buds
2- Breaks self-incompatibility system
3- About 25% decrease in fruit weight!!!

Yellow pitahaya  4n →  8n

1- Very small fruits – lacking commercial value
Production of homozygous Haploid-DH lines

Technique
This approach allows the production of haploid plants. Homozygous lines from heterozygous donors could be obtained through a single-step
Anther culture

Callus formation

Embryoids formation
Ovule culture

1- Ovule in culture
2- Embryoid development
3- Callus formation
4- Plant regeneration
Abnormal plants - up to 5%
Hardening-off
Haploid plant with half number of chromosomes / total DNA per cell
We obtained haploid plants from anther and ovule culture in red and yellow pitahayas.
Few samples.....

More than 2,000 plants for evaluation
Yellow pitahaya “haploid” plants start to bloom
Embryo rescue

Plated

2 weeks

4 weeks

6 weeks

8 weeks

10 weeks

Embryo rescue

Embryo rescue
Embryo rescue

2 weeks

3 weeks

4 weeks

6 weeks

8 weeks

10 weeks

Hardening-off

2 month
This unique plant material offers us an opportunity to identify elite lines in terms of yield, fruit quality, resistance to disease, and drought tolerance, enhances our potential to improve breeding efficiency.
Perspectives

Thousands of plant for selection.

Improved cultivars for GROWERS?

QTL’s to map genome/ secondary metabolites

Elucidating genetic relationships among vine cactus species
Development of new additional products

- Natural food colors
- Ornamental
Hylocerrenin Tolerant to Pasteurization

Strawberry
Opuntia
Red Pitahaya

Ice Cream
Ornamental uses
Next morning 6 am
withered
In summary, there is a wealth of genetic variability in vine cacti waiting for us in the wild. These plants have inherent High Water Use Efficiency (WUE) with tolerance to other stresses. These plants in addition to providing food and feed, have industrial and medicinal uses.
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