# PITAYA, *HYLOCEREUS UNDATUS* (HAW) - A POTENTIAL NEW CROP FOR AUSTRALIA

## SCIENTIFIC NAME: *Hylocereus undatus*
## FAMILY: Cactaceae

### Background

*The author, a final year student at Wageningen Agricultural University, Netherlands, spent his practical period (May to September 1997) at the New Crops Program, University of Queensland Gatton College, Lawes, Queensland. Part of the period was dedicated to a literature review and an evaluation of pitaya in Australia, with the cooperation of WANATCA, DPI&F (Department of Primary Industry & Fisheries, Northern Territory), Ben Gurion University (Israel), and growers in Australia.*

Pitaya was present in a list of forty plants compiled by the organisers of a Tropical Fruit Planning Workshop held in Cairns in July 1997. Primary producers at the Workshop put pitaya in the top ten of crops worth further research and commercialisation. The fresh fruit was identified and targeted as potential product.

A preliminary search on pitaya, by means of amount of published papers worldwide indicated it was among crops with recent increasing attention. This attention has been limited to its appearance in foreign literature and the presence of the crop in developing countries. Recent research carried out in Israel towards drought resistant crops for the Negev Desert has drawn attention to this cactus grouping.

Historical production of the fruits could indicate a promising market and production potential. Its distribution, and geographic and political characteristics may have favoured development of local markets. Growing attention towards drought resistant plants, and expansion of production areas under possible global warming, are factors of relevance in Australian agriculture.

### Introduction

Pitaya is a common name applied to a broad variety of warm-climate cacti fruit (Table 4.1), from different species and genera. It represents an interesting group of underexploited crops with potential for human consumption.

### Table 4.1. Name, common name and source of species and genera of cacti, known as pitaya or pitahaya, illustrating the variety of edible fruiting species

| No. | Name | Common Name |
|---|---|---|
| 1 | *Acanthocereus occidentalis* Br. & R. | pitaya |
| 2 | *Acanthocereus pentagonus* | pitahaya, naranjada |
| 3 | *Acanthocereus tetragonus* (L.) Humlk | pitaya, acanthocereus |

| | | |
|---|---|---|
| 4 | *Cereus peruvianus* (L.) Muller | pitaya, apple cactus |
| 5 | *Cereus thurberi* | pithaya |
| 6 | *Echinocereus conglomeratus* | pithaya de agosto |
| 7 | *Echinocereus stramineus* | Mexican strawberry, pitahaya |
| 8 | *Escontria chiotilla* (Weber) Br. & R. | pitaya, jiotilla |
| 9 | *Hylocereus costaricensis* (Weber) Br. & R. | pitaya, pitahaya |
| 10 | *Hylocereus guatemalensis* (Eichl.) Br. & R. | pitaya, pitahaya |
| 11 | *Hylocereus ocamponis* (Salm-Dyck) Br. & R. | pitaya roja |
| 12 | *Hylocereus polyrhizus* (Weber) Br. & R. | pitaya, pitahaya |
| 13 | *Hylocereus undatus* (Haw) Br. & R. | pitahaya oregona, red pitaya, strawberry pear, dragon fruit, dragon pearl fruit, thang loy, pitaya roja |
| 14 | *Myrtillocactus geometrizans* (Mart.) Cons. | pitaya |
| 15 | *Selenicereus megalanthus* (K. Schum ex Vaupel) Moran | pitaya amarilla, yellow pitaya |
| 16 | *Stenocereus griseus* (Howarth) Buxbaum | pitaya de mayo |
| 17 | *Stenocereus gummosus* (Engelsm) Gilbs. | pitaya agria |
| 18 | *Stenocereus queretaroensis* (Weber) Buxbaum | pitaya de queretaro |
| 19 | *Stenocereus stellatus* (Pfeiffer) Riccobobo | pitaya de augusto |
| 20 | *Stenocereus thurberi* (Engelsm.) Buxb. | pitaya dulce |
| 21 | *Stenocereus thurberi* var *litoralis* (E.) B. | pitaya dulce |

Sources: Fletcher, 1997; Nerd et al., 1997; Mizrahi et al., 1996a; Janick, 1996.

**Taxonomy**

Various crops are referred to as producing pitayas, a variety of columnar and climbing cacti bear these delicious, medium to large fruits. *Hylocereus guatemalensis*, referred to at the Tropical Fruit Crops workshop, probably originates from Kamerunga. Unfortunately, no trials were carried out as far as is known, and no data are available on pitaya from the research station. A yellow fruiting species originating from this station is present at the DPI&F in the Northern Territory.

Early imports in North Queensland from Colombia are recorded as *Hylocereus ocampensis*, red pitaya, and *Cereus triangularis*, yellow pitaya. Probably the yellow pitaya was *Selenicereus megalanthus*, and the red pitaya, *Hylocereus ocamponis* or *Hylocereus undatus*. *Cereus triangularis* is a synonym of *Hylocereus undatus* (Table 1).

*Hylocereus* species have been widely distributed in the past. This genus is commercially grown in the Americas, originally, and in Vietnam, where it was imported by the French and is locally recognised as native species by now. Recent research and development in Israel provides a rich source of information.

Closely related species may have importance in breeding. The small group of crawling cacti comprising *Hylocereus, Selenicereus*, and *Mediocactus* species should be given attention. They are assigned to the tribe Cerecae, subtribe Hylocerecae. *Mediocactus* is intermediate between the others, according to Britton & Rose.

Similar production and cultural conditions are required for these species, which permits some comparison between the species. Cullmann et al. mention 24 and 25 species of *Hylocereus* and *Selenicereus* species respectively. Distribution of the species occurs roughly from Mexico and Texas to Peru and Argentina.

Performance in Australia, its commercial production in Latin America, Vietnam and Israel, and availability of literature have broadened and restricted further research to crawling cacti. An analysis of the most important species is given in Table 4.3.

**Production**

The pitayas described are fruit from segmented, vine-like crawling cacti. They have aerial roots, and originally lived an epiphytic life. The roots are used to attach themselves to supports. They are shade tolerant and flower at night.

The large white flowers gave them their popularity as ornamentals, named Moonflower, Lady of the Night or Queen of the Night. Fruits are brightly coloured, and have an unique, attractive appearance. The red pitaya bears large fruits, which are pink, red, or mauve in colour, weighing around 150-600 g and containing many, small edible seeds. Their pulp varies from white to various hues of red.

The yellow pitaya (*Selenicereus megalanthus*) is a smaller fruit, and is covered with many small clusters of spines, which are easily brushed off the fully ripe fruit. It is commercially grown in Colombia, has white pulp with higher sugar levels. Fruits of the climbing cacti are harvested when changing colour, and tend to hold for at least one week. Cooling (10-12 degrees C) does not seem to affect the fruit adversely.

Fruit set takes 30-50 days after flowering, and 5-6 fruit crop cycles (between May and November) a year are seen in Nicaragua, yielding 10-12 t/ha in the fifth year. Orchards of the same species yield 30 t fruit/ha/year in Vietnam. The yellow pitaya differs remarkably in fruit characteristics and fruit development, with a fruit development time of about five months.

The crawling cacti, particularly *Hylocereus*, have gained popularity in ornamental production in greenhouses in Europe and the United States as rootstock for other, slow-growing ornamental cacti. According to Backeberg, all species bear red fruits, except for a very few *Selenicereus* species.

The pitaya is a species of dry tropical climates. Maximum temperatures of 38-40 degrees C, and minor short frosts (0 degrees C) are survived without major damage.

Rainfall requirements are modest (600-1300 mm), while excessive rain leads to flower drop and fruit rot. Due to their epiphytic life in the areas of origin, these cacti formed aerial roots to find nutrients in cracks where organic material concentrates. There is a positive response in growth to the amount of organic matter in the soil, but highest number of roots and greatest bud number are obtained in sand.

Cultural practices employ a trellis, or, traditionally, old tree stumps or living tree posts. As the plants have high tolerance to sulphurous gases, commercial production in Nicaragua is found on the slopes of the Mount Santiago volcano. In Nicaraguan plantings, propagation is done by stem cuttings, placed at 3 x 5 m on living tree posts. Nutrients can be applied by foliar spraying, or through fertilizer spreading.

Some pests and diseases are recorded on pitaya. Problems in Australia are most likely to involve birds, possums, rats, or bats feeding on the fruit. Observations in Australia indicated similar effects to those caused in Central America by the bacterium *Xanthomonas campestris*, causing rot in the stem flesh, leaving the main veins intact. Except for local insect attack, a fungus (*Dothiorella*), causing brown spots, is mentioned as one of the important problems in Nicaragua.

**Table 4.3. Selection of important species of Cerecae and Hylocerecae, for fruit potential, with synonyms, names used referring to the species and common names.**

| Name | Synonyms | Some References Made From | Common Name |
|---|---|---|---|
| *Selenicereus megalanthus* (K. Schum. ex Vaupel) Moran | *Cereus megalanthus (K. Schum. ex Vaupel), Mediocactus megalanthus* (K. Schum. ex Vaupel) | *Hylocereus triangularis, Cereus triangularis, Mediocactus coccineus, Hylocereus* sp. Katom | Yellow pitaya, pitaya amarilla |
| *Hylocereus undatus* (Haworth) Br. & R. | *Cereus undatus* Haw., *Cereus triangularis* Haw., *Cactus triangularis* L., *Cactus trigonus* Plum. | | pitahaya, pitaya roja, dragon fruit, dragon pearl fruit, thang loy |
| *Hylocereus costaricensis* (Weber) Br. & R. | | | pitaya, pitahaya, pitaya silvestre, wild pitaya |
| *Hylocereus polyrhizus* (Weber) Br. & R. | | | pitaya, pitahaya |

Sources: Barbeau, 1990; Weiss et al., 1995; Mizrahi et al. 1997; Jorge et al., 1989

Freshly cut stems and flowers of *Selenicereus grandiflorus*, in particular, are used in the preparation of drugs with a spasmolytic effect on the coronary vessels, and to promote blood circulation. For this purpose, cuttings are cultivated in hot-houses. *S. megalanthus* contains the heart tonic captine. The *H. undatus* fruit is noted to be useful in combating anaemia. Stems of the species are sold in homeopathy.

Some germplasm is already available in Australia. A few growers in the Northern Territories and Queensland have some species. The DPI&F in Darwin recently addressed attention to pitaya. Since Israeli research and breeding has been carried out, imports of this material, supported by local plant improvement, should yield good commercial varieties and hybrids.

Experience in growing this crop in Australia shows low yields. Two fruiting cycles, one in May, and a smaller one in August, have been recorded in the Brisbane area. Enquiries from growers in north Australia indicate difficulties with fruit set. Growth and performance in Australia are so far not very promising. Although good yields are obtained, sunburning, insufficient pollination, and unknown nutritional requirements can be identified as causing this poor performance.

A limited production in California, grown on a small scale by a few producers, has led to occasionally selling in Farmers Markets on a individual basis.

**Marketing**

Although considerable investments seem to be necessary in commercial production of pitayas, Israeli observations show relatively cheap trellising could be sufficient. If providing shade, however, proves to be necessary in commercial production, extra costs will be incurred. Solutions such as netting will protect as well against possible bird attack.

Rare, attractive fruits will draw attention at the market place in the first phase. Customer demand at the moment is fragile and very low because the fruit is unknown at the markets. The market size for exotic fruit is limited, but growing. Consumer acceptance, measured in the Brisbane markets, gave an indication of good performance for yellow pitaya, and moderate for red pitaya, as fresh fruit. Musky smell and taste of the red variety might explain limited enthusiasm.

In August, market prices of $7-8 per kg in Barcelona and $40 per 8-12 pieces were observed. Local Californian produce was sold at $8-10/ kg through 1996. Due to its novelty and small amounts traded, no more reports were made. Barbeau however made notice of several consignments exported to Europe, and Utopia Pty Ltd is successfully importing Colombian pitayas into Europe.

One species is grown in Vietnam. Pitayas are commercially produced and sold as dragon fruit, dragon pearl fruit or thang loy. Production takes place along the coast from Nga Trang to Ho Chi Ming City. Very little information, however, seems to be available from Vietnam. Some articles are being translated from Vietnamese at the DPI&F.

Vietnamese exports to other Asian markets show potential markets in Hong Kong, China, and Japan for high quality fruit. Twenty two tons of pitaya were imported in Japan in 1988. Specimens of the Vietnamese fruit have been imported into the Northern Territory.

The variability in size, taste and colour of the fruits indicates the strong need for coordination in commercialisation. In respect to potential future export, attention should be addressed towards the characteristics of the Vietnamese *H. undatus* and exported varieties from Israel. The red pitaya (*H. undatus*) as referred to by Barbeau, grown in Nicaragua, is red-fleshed.

**Evaluation**
Fruits are picked when most Australian-grown tropical fruits are finished. Fruits are widely appreciated, especially chilled or served with lemon. Compared to prickly pear, these fruits are easier to handle due to the thornless skin (or thorns are easily removed before entering the market, in the case of *Selenicereus*). Their very small, black seeds are similar to the seeds of the kiwi.

There is an organised tropical fruit industry present in the northern regions of Australia. Transport and handling of a new fruit, if information is provided to concerned parties, should be carried out relatively easily. With regard to infrastructure, specific knowledge of cultural practices and problems in picking the fruit, have been gained in Israeli production.

Profitability is expected to be high in the first phase. The attractive and unique fruit fits into the Australian market, regarded as willing to try out new products. There is a growing trend in demand for tropical fruit and prices are high. Additionally, export to Asian countries, where the fruits are already known, is a market for high quality produce.

Weaknesses are seen in the lack of any experience in Australian markets. No commercial growers or plantings have been made in Australia as yet. Consumer awareness will demand education and time before the product might be widely accepted. Lack of resources is a general constraint, arguing for good communication between those involved. Prices are likely to fall if higher production levels are obtained. To succeed in providing future export markets, identification and coordination between growers and industry are likely to be keys to success.

The diversity of varieties present under one name is likely to cause difficulties for consumers in recognising of the product. Pitaya, dragon fruit, or other brand names could be applied to different varieties, and be a solution to problems with interpretation of the product name.

Better varieties and current research in Israel create opportunities for commercialising pitaya in Australia. Import of germplasm to be able to carry out breeding programs or to introduce Israeli hybrids are options. Pitayas have a relatively fast return, for tropical fruits, starting to bear in the second year, reaching full production in five years.

Low inputs of water, fertiliser and pesticides, could make organic production a good opportunity, still producing high quality fruit. To maintain high prices and demand in new exotic fruits, high quality has proven to be very successful.

Quarantine to import plant material from overseas, and particularly phytosanitary regulation limiting export of fruits to the Asian markets, could be seen as threats to the developing pitaya market. Cheap commercial production in Vietnam, Central America and other countries could be serious competitors in providing export markets to Australian producers. Pitayas act as hosts for fruitfly, but the Japanese Plant Quarantine can provide certificates if proper disinfestation is undertaken. Import of germplasm into Australia takes time.

**Further Research**
Industrial processing of the red fruits, for ice-cream, juice, wine, fruit salads and recipes should be further researched and published. Markets are currently restricted

to fresh fruit due to lack of information for other uses. A restaurant supplier in Brisbane showed enthusiasm both to process and consume fruits.

A Nicaraguan study has shown that the pulp contains 84.4% water, 0.4% fats, 1.4% protein, 11.8% carbohydrates, 1.4% cellulose, and 0.6% ash. Red varieties contain anthocyanins, giving a strong red colour. Increasing sugar levels would increase consumer acceptance.

Novelty and lack of experience in Australia should warn producers to continuously evaluate markets. To secure future markets, coordination is important from the beginning. Consumer education, and analysis are important to respond to unexpected occurring problems.

So far, no records in Australia are known of production levels comparable with data from its region of origin. We might assume higher production will be obtained when providing shade. Bleaching and death occurs at photon flux up to 2000 to 2200 moll photons/m/s in *S. megalanthus* and will cause reduction in yields for most areas.

Research on environmental factors influencing induction of buds in order to manipulate them is lacking. Flowering is initiated at the end of the dry season in Central America, and continues throughout the wet season. Barbeau notes this might be a dependence on day length. Fruiting occurred in two to three waves in experimental production in Israel, from June to November, possibly temperature related.

However their adaptability and performance in the field are much less than that of opuntia, where drought resistance and high seed production favour distribution in the wild. Spread was found minimal of *H. undatus*, and not seen as threat, because of low fruit set.

Several pitaya species planted in the Negev Desert in Israel are being examined. At present, the cytogenetic make-up of *Selenicereus megalanthus* is being studied with the aim of understanding its low seed set and consequently low fruit weight. Cross pollination between *Hylocereus* species yield heavier fruit. As well, crop improvement in *Cereus peruvianus*, with similar fruit, could act as competition for crawling cacti. These latter columnar cacti don't require any support and are also characterised by high growth rates. Their good performance in high salinity and lower susceptibility to sun burning could be advantages in the same potential production areas.

Pollination problems are often met with in Australian-grown pitaya. Moths and bats are the native pollinators. However, their short individual flower opening period - one night - requires high presence of pollinators. Ants are observed pollinating flowers, honey bees visit flowers, but are low effective in pollination. The effect of pollination was researched by Weiss et al., and showed higher fruit weight for cross-pollination between *Hylocereus* species. Some of the species were self-sterile.

Disinfection measures and other postharvest treatments have to be developed. Australia is exporting mangoes to Japan, and this market, together with Hong Kong and Taiwan for fresh tropical fruit as imports, is growing.

**Notes**

In selecting pitaya as a crop and product, some selectivity has been inevitable. I have attempted to give an indication of factors that were used here, however this was

difficult and is not complete. Potential growers should define markets and product themselves and make a business plan according to the specified target.

A lot of plants from the Americas, tropical and subtropical species, have been cultivated, but never become well-known. Their richness in semi-arid crops is likely to be a promising resource for relatively dry regions. Climate change and increasing $CO_2$ levels should open eyes and make us aware to treat our planet with more respect. At the same time, CAM plants and species from arid zones should get more attention if present trends continue.

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DATE: February 1998

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