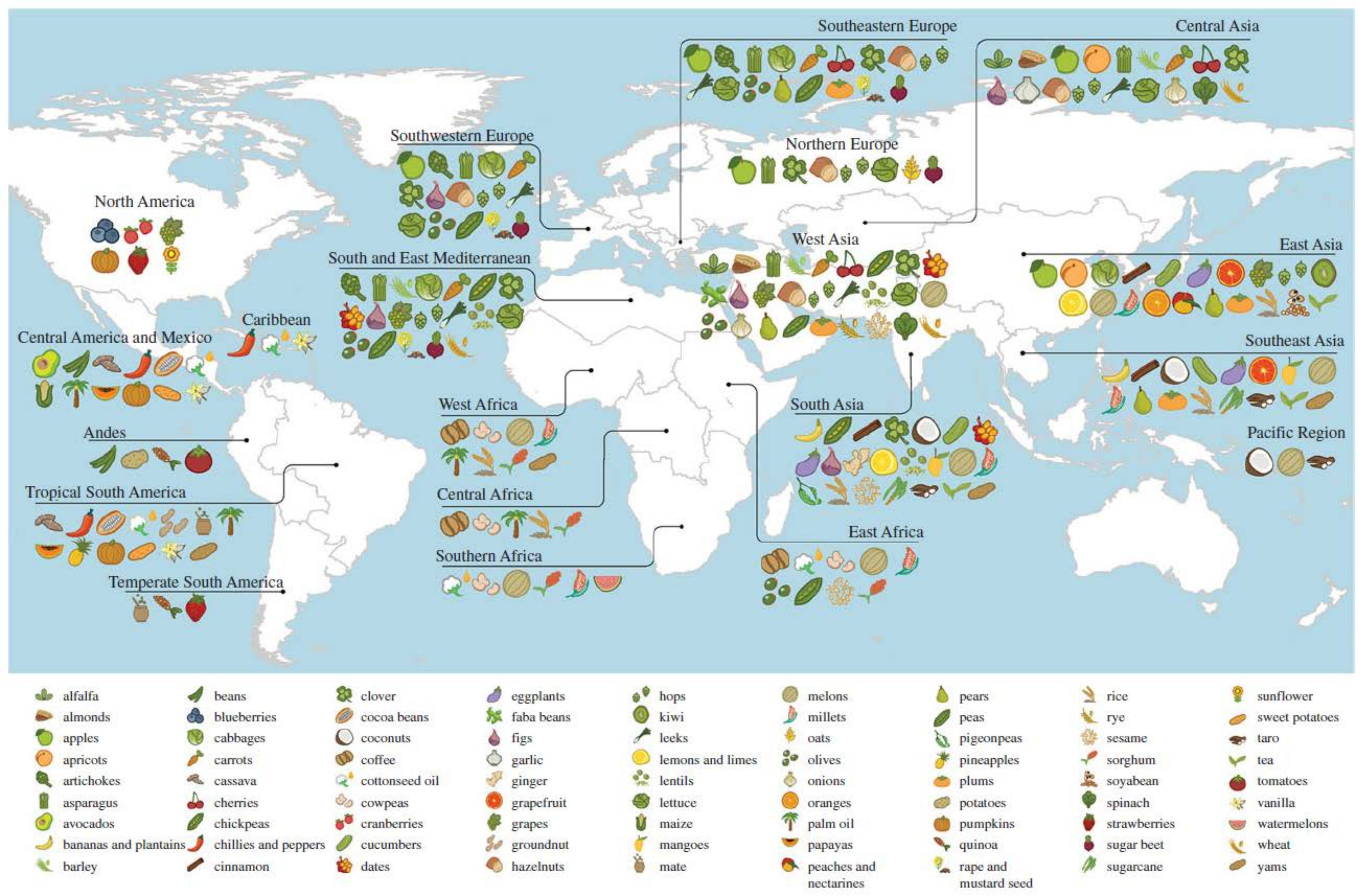
# Biotechnological approaches for utilization of selected tropical fruit crops

Prof. Dr. Víctor M. Jiménez
CIGRAS-IIA-FSC

5-12-2017
Seminario Regional FSC

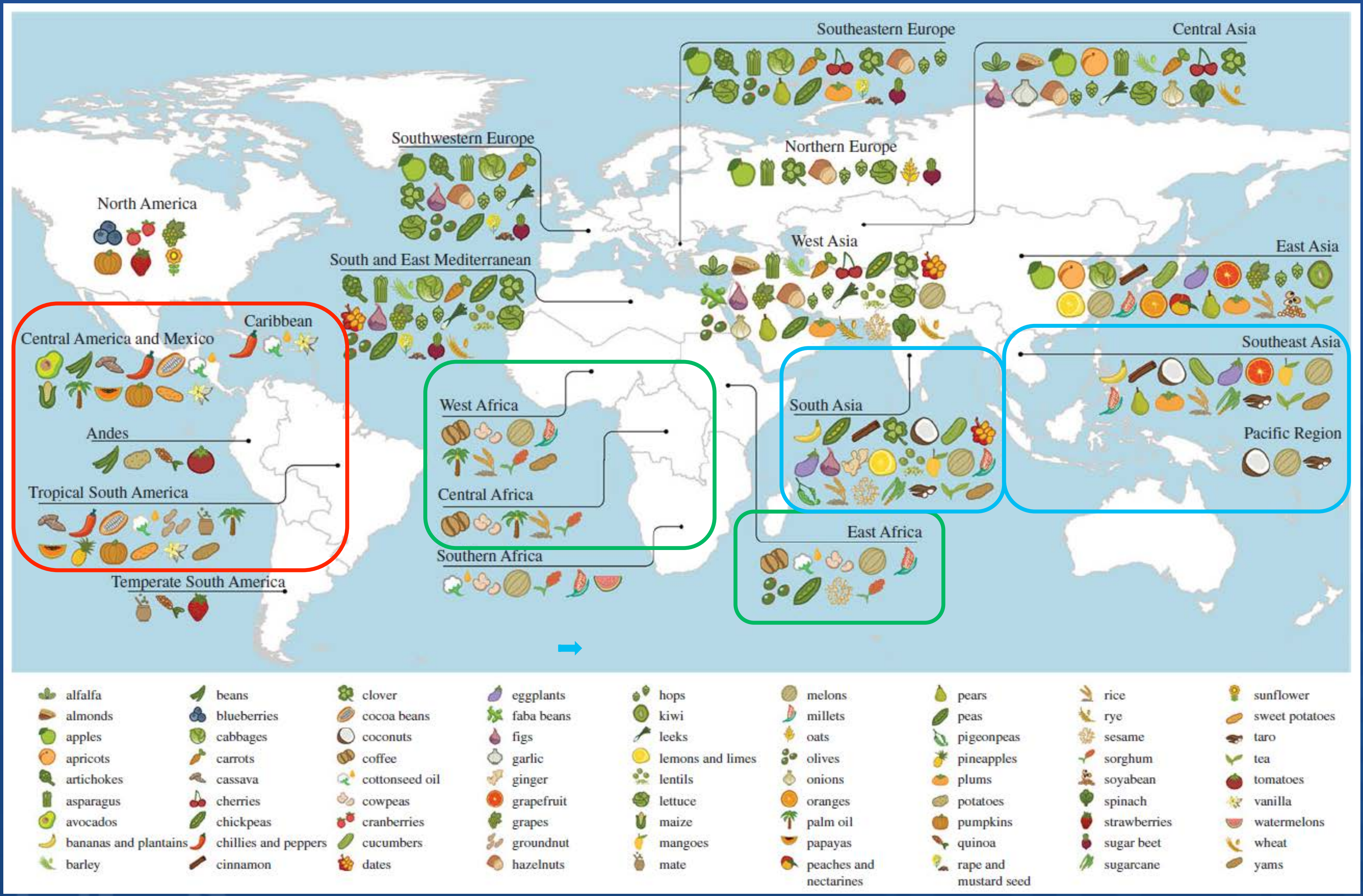
# Primary regions of diversity of major agricultural crops worldwide






Khoury et al. (2016) Proc. R. Soc. B 283:20160792

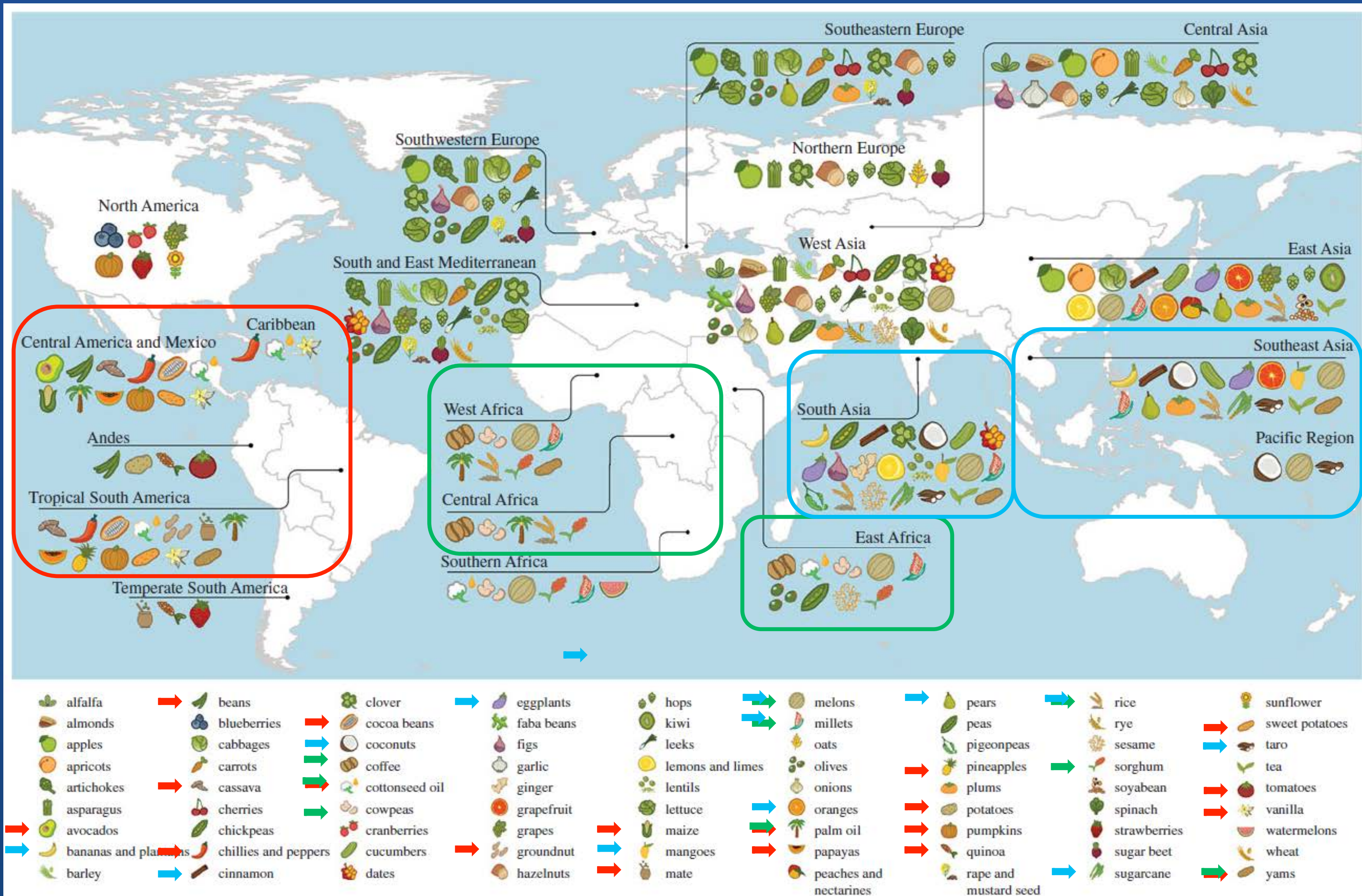
# Primary regions of diversity of major agricultural crops worldwide






Khoury et al. (2016) Proc. R. Soc. B 283:20160792

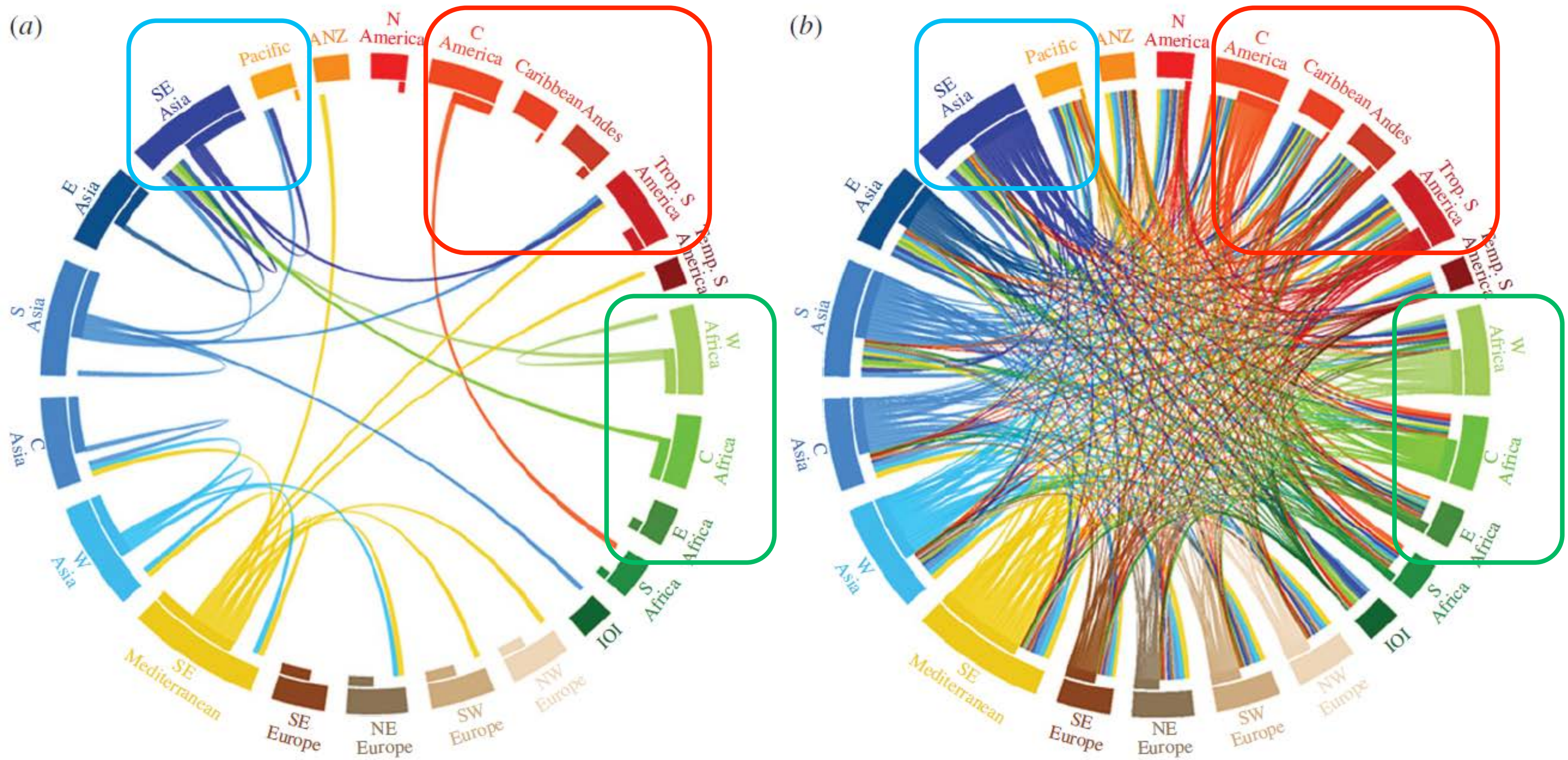
# Primary regions of diversity of major agricultural crops worldwide






Khoury et al. (2016) Proc. R. Soc. B 283:20160792

# Circular plots linking the primary regions of diversity of food crops with their current importance in the context of calories (kcal capita−1 d−1) in regional food supplies




Khoury et al. (2016) Proc. R. Soc. B 283:20160792

# Until 2030

- 2030: it will be necessary to feed additional 1.2 billion people (current population of India)

- Feasible?
  - Current production: 5000 calories (kilocalories) per person per day
  - Requirements: 1800 calories per person per day
  - Limitations:
    - Other uses for crops (biofuels)
    - Losses (field and postharvest)
    - Distribution
    - Waste
    - Disasters and similar conditions (climate, wars, etc.)

# Until 2030

- 2030: it will be necessary to feed additional 1.2 billion people (current population of India)

- Feasible?
  - Current production: 5000 calories (kilocalories) per person per day
  - Requirements: 1800 calories per person per day
  - Limitations:

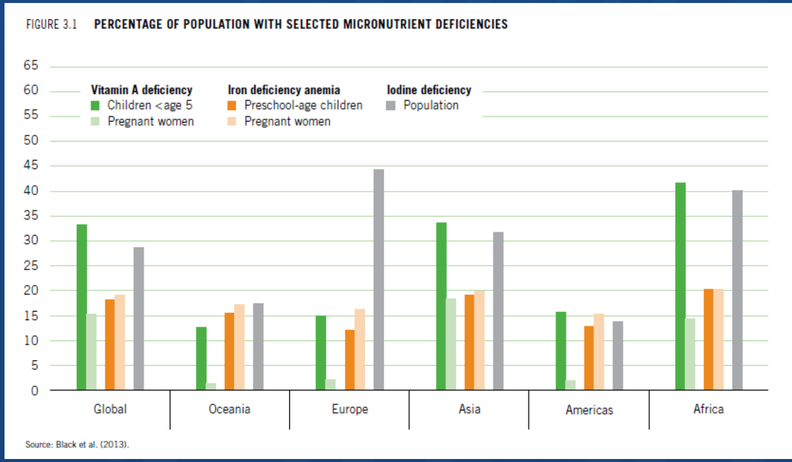
Malnutrition: inadequate and unbalanced (macro and micro)-nutrient intake that can lead to undernutrition, overnutrition and "hidden hunger".

    - Waste
    - Disasters and similar conditions (climate, wars etc.)

# Hidden hunger

- Definition: Deficiency of micronutrients and essential vitamins in the diet.

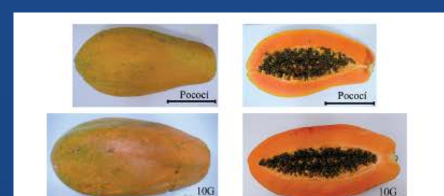
- Affects 2 billion people in the world.
- Double burden: can occur simultaneously to adequate and even over-consume of energy foods (fats and carbohydrates).
- Health can be affected on the long term
- Negative socio-economic consequences are to be expected as well (affecting productivity of the individuals).




Global Hunger Index 2014

# How to fight hidden hunger?

- Food fortification (during processing).
- Biofortification (by means of plant breeding – conventional or through biotechnology).
- Supplements (immediate effect).
- Diet diversification (new food sources).





# Facts about agricultural diversity

- FAO estimates show that:
  - There are 250 000 plant varieties with agricultural potential.
  - Less than 7 500 are being currently used.
- World food production:
  - Depends on ca. 150 plant species
  - Twelve provide ¾ of world food.
  - More than 50% of the calories are obtained from three mega-crops:
    - Rice
    - Wheat
    - Maize

- Therefore, to increase food security on the long term, it is necessary to include additional plant species in the human diet (consider climate change).

# Domestication of underutilized climate change potentially resilient crops – the case of pitaya (*Hylocereus* spp.)

Andrés Hernández, Paúl Solórzano-Cascante, Ester Vargas, Víctor Villavicencio, María Viñas, Dessireé Zerpa-Catanho, Patricia Esquivel, Víctor M. Jiménez

# Red pitaya

- Genus: *Hylocereus* (Cactaceae).
- Climbing cactus, native to Mesoamerica (Southern Mexico to Northern South America)
- Climate change potentially resilient crop:
  - Cactus plant
  - CAM photosynthesis
- Fast-growing perennial plants
- Plants have elongated three-ribbed stems and climb on trees and rocks
- Cultivation: Israel, Vietnam, Mexico, Colombia, Nicaragua, Costa Rica

## CAM Plants

- **Hot, dry environments**.
- **5% of plants (cactus and ice plants).**
- **Stomates closed during day.**
- **Stomates open during the night.**
- Light rxn - occurs during the **day**.
- Calvin Cycle - occurs when $CO_2$ is present.

# Red pitaya

- Produces attractive edible fruits for fresh consumption and processing (pigments, mucilage, etc.)
- The fruits are medium to large berries covered with large scales, and are commonly known as pitayas, pitahayas or dragon fruits.
- Different species and genotypes within the genus differ in size, shape, taste, and color.
- Pulp color may range from white to various hues of red and purple.
- Purple-fleshed dragon fruit has been suggested as a viable source of betalains

- In Central America, particular names have been assigned to certain genotypes of purple-fleshed pitaya, depending on the fruit morphology, scale number and shape.
- ´Lisa´, ´Nacional´, ´Orejona´, ´Rosa´ and ´San Ignacio´ are common genotypes in Nicaragua and Costa Rica.





## First step: know you subject
## Physico-chemical characteristics of the pitaya fruits

# Physico-chemical and morphological characterization of fruits from different *Hylocereus* genotypes

Significant differences were observed between genotypes concerning

- fruit weight and size
- skin thickness
- proportion of flesh
- amount of seeds
- pH values
- malic acid contents
- total soluble solids
- density
- pectin and glucose contents of the juices

According to the results obtained, 'Nacional' fruits are suitable for processing, whereas 'San Ignacio' may be preferred for fresh fruit consumption.

Journal of Applied Botany and Food Quality 81, 7 - 14 (2007)

[1]Institute of Food Technology, Section Plant Foodstuff Technology, Hohenheim University, Stuttgart, Germany
[2]Escuela de Tecnología de Alimentos, Universidad de Costa Rica, 2060, San Pedro, Costa Rica

**Comparison of morphological and chemical fruit traits from different pitaya genotypes (*Hylocereus* sp.) grown in Costa Rica**

Patricia Esquivel[1,2], Florian C. Stintzing[1]*, Reinhold Carle[1]

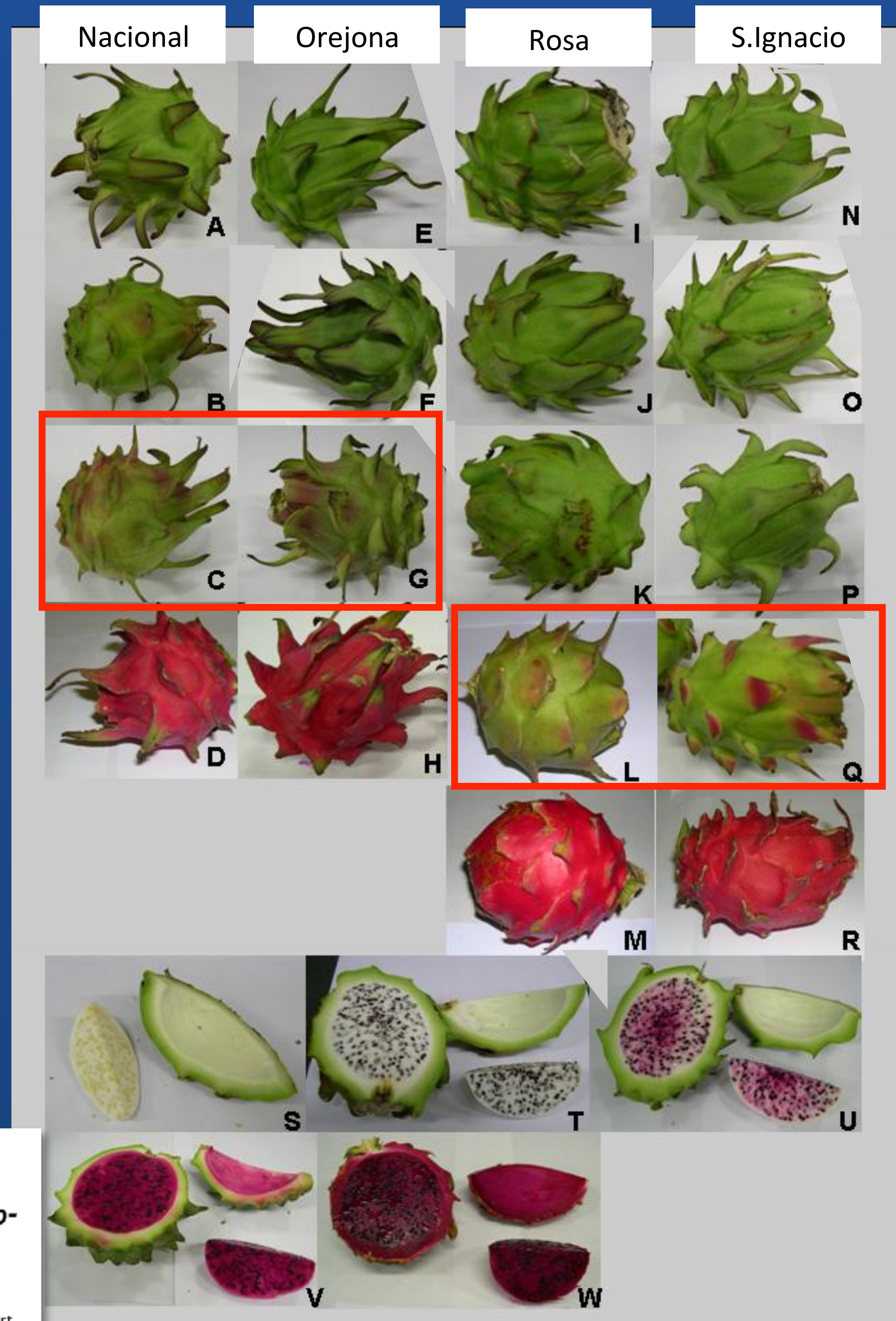
(Received October 27, 2006)

# Fruit development in several *Hylocereus* genotypes

Pitaya fruits show their best quality when allowed to ripe on the plant. Sometimes they must be picked unripe to avoid damage in the field and to better withstand postharvest handling.

Two groups:

1. ´Nacional´ and ´Orejona´, with smaller fruits with shorter ripening times
2. ´Rosa´ and ´San Ignacio´ with larger fruits and delayed fruit ripening.




- 17
- 21
- 24
- 28
- 32

Days after anthesis

Europ.J.Hort.Sci., 72 (5). S. 231–238, 2007, ISSN 1611-4426. © Verlag Eugen Ulmer KG, Stuttgart

**Fruit Characteristics during Growth and Ripening of different *Hylocereus* Genotypes**

P. Esquivel[1,2], F. C. Stintzing[1] and R. Carle[1]
([1]Institute of Food Technology, Section Plant Foodstuff Technology, Hohenheim University, Stuttgart, Germany and [2]Escuela de Tecnología de Alimentos, Universidad de Costa Rica, San Pedro, Costa Rica)

# Antioxidant compounds in *Hylocereus* genotypes and their activities

Although, other minor components may contribute to the anti-oxidative activity of the juices, the anti-oxidative capacity is mainly explained through the high levels of total betalain contents.

Together with the well known betalains previously reported in *Hylocereus* fruits, various precursors of the betalain biosynthesis were observed

**Phenolic Compound Profiles and their Corresponding Antioxidant Capacity of Purple Pitaya (*Hylocereus* sp.) Genotypes**

Patricia Esquivel[a,b], Florian C. Stintzing[a,c,*], and Reinhold Carle[a]

[a] Institute of Food Science and Biotechnology, Section Plant Foodstuff Technology, Hohenheim University, August-von-Hartmann-Straße 3, D-70599 Stuttgart, Germany
[b] Escuela de Tecnología de Alimentos, Universidad de Costa Rica, 2060 San Pedro, Costa Rica
[c] Present address: WALA Heilmittel GmbH, Dorfstraße 3, D-73087 Bad Boll/Eckwälden, Germany. E-mail: florian.stintzing@wala.de

* Author for correspondence and reprint requests

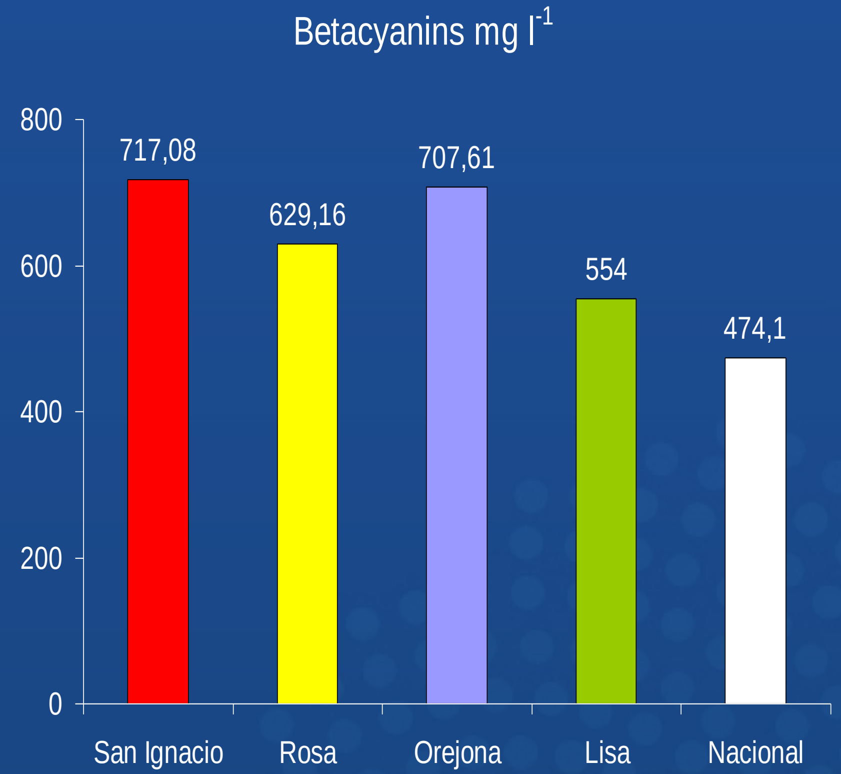
Z. Naturforsch. **62 c**, 636–644 (2007); received February 15/March 13, 2007

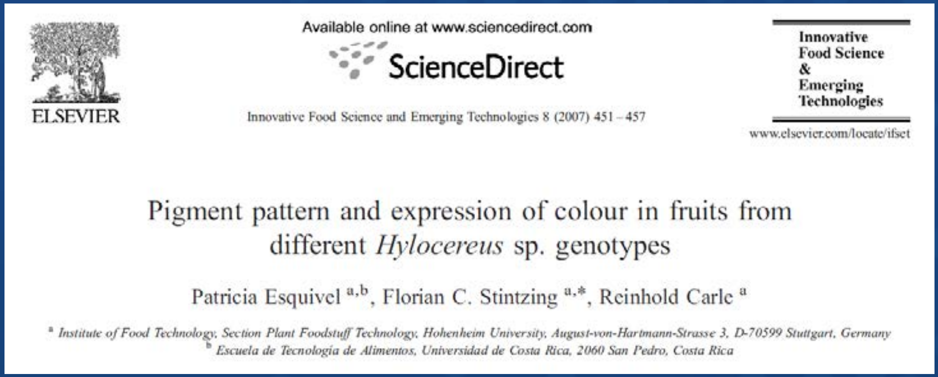
# Color parameters and betalain profiles of juices from different *Hylocereus* genotypes

*Hylocereus* genotypes may differ in their color quality and pigment content, which is crucial for the selection of appropriate plants for an emerging pitaya market.

"Rosa" showed the highest betanin and isobetanin contents, whereas phyllocactin and hylocerenin were predominant in "San Ignacio".

Apart from reporting the betalains neobetanin and gomphrenin I for the first time, indicaxanthin was the first betaxanthin so far detected in pitaya fruits



Available online at www.sciencedirect.com
ScienceDirect
ELSEVIER
Innovative Food Science and Emerging Technologies 8 (2007) 451–457
Innovative Food Science & Emerging Technologies
www.elsevier.com/locate/ifset


Pigment pattern and expression of colour in fruits from different *Hylocereus* sp. genotypes


Patricia Esquivel [a,b], Florian C. Stintzing [a,*], Reinhold Carle [a]

[a] Institute of Food Technology, Section Plant Foodstuff Technology, Hohenheim University, August-von-Hartmann-Strasse 3, D-70599 Stuttgart, Germany
[b] Escuela de Tecnología de Alimentos, Universidad de Costa Rica, 2060 San Pedro, Costa Rica

# Second step: potential uses, market potential
# Industrial applications


# Red/purple pigments

Anthocyanins

- Color
  - Red
  - Purple blue
- Found in
  - Grapes, cranberries, strawberries, red cabbage
- Used in carbonated beverages

Betalains

- Color
  - Red
  - Purple blue
- Found in
  - Red beet, cactus pears, pitaya
- For dairy products
- Colour stable in broad pH values

## Betalain sources

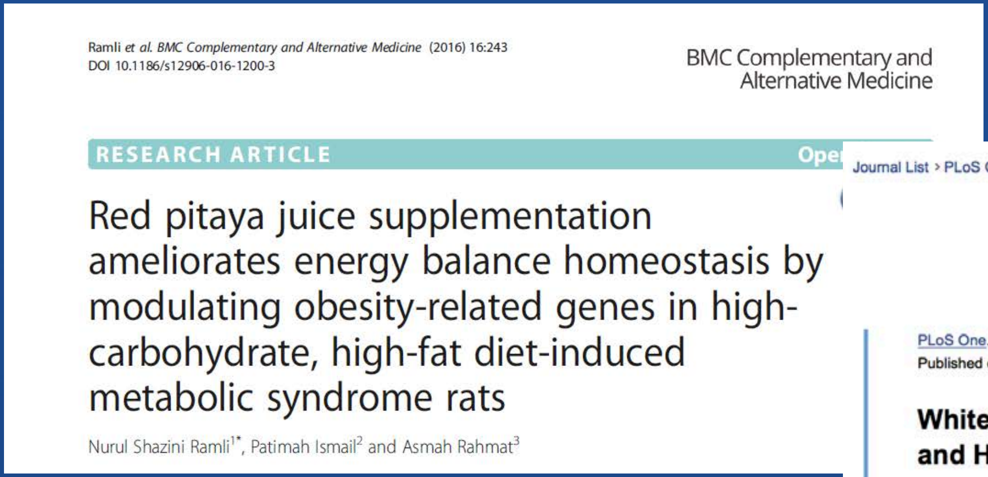
Red beet (*Beta vulgaris*)

- High levels of nitrates associated with carcinogenic nitrosamines
- Earthy smell

Pitaya (*Hylocereus* sp.)

- High levels of pigment (280-400 mg of betacyanins/kg of pulp)
- Do not have the red beet negative characteristics

# Beneficial effects of betalains


Ramli *et al. BMC Complementary and Alternative Medicine* (2016) 16:243
DOI 10.1186/s12906-016-1200-3

BMC Complementary and Alternative Medicine

RESEARCH ARTICLE

Red pitaya juice supplementation ameliorates energy balance homeostasis by modulating obesity-related genes in high-carbohydrate, high-fat diet-induced metabolic syndrome rats

Nurul Shazini Ramli[1*], Patimah Ismail[2] and Asmah Rahmat[3]


Journal List › PLoS One › v.11(2); 2016 › PMC4767368

PLOS ONE A Peer-Reviewed, Open Access Journal

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PLoS One. 2016; 11(2): e0149670.
Published online 2016 Feb 25. doi: 10.1371/journal.pone.0149670

PMCID: PMC4767368

**White Pitaya (*Hylocereus undatus*) Juice Attenuates Insulin Resistance and Hepatic Steatosis in Diet-Induced Obese Mice**

Haizhao Song,[1,2] Zihuan Zheng,[1] Jianan Wu,[1] Jia Lai,[1] Qiang Chu,[1] and Xiaodong Zheng[1,2,*]

Jonathan Peterson, Editor

Author information ▶ Article notes ▶ Copyright and License information ▶

PLoS One

- Good source of antioxidants
- Anti-inflammatory
- Antiradical
- Non-toxic
- Non-allergenic

Betalains have high potential for coloring foodstuff

# Pitaya pulp maceration for the production of coloring foodstuff

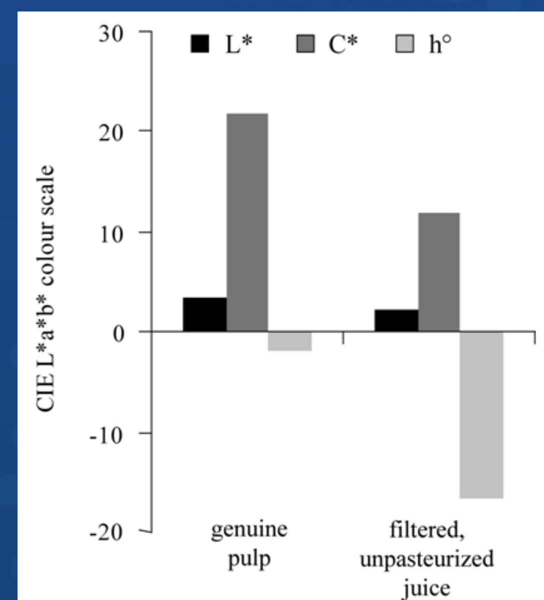
Mucilage hinders pigment extraction.

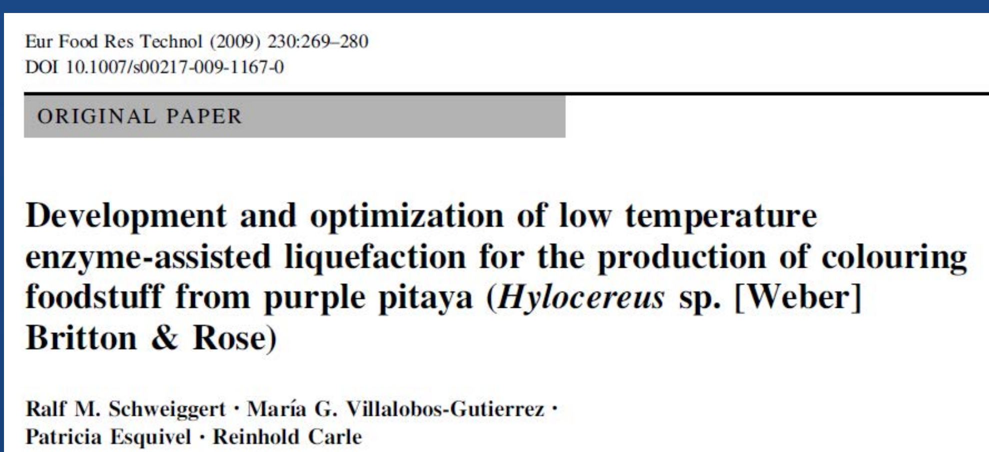
New protocol was developed: involves low-temperature enzyme-assisted liquefaction.

Juice yield was significantly increased.

Seeds could be easily separated.

Color shift to bluish tones.





Eur Food Res Technol (2009) 230:269–280
DOI 10.1007/s00217-009-1167-0

ORIGINAL PAPER

**Development and optimization of low temperature enzyme-assisted liquefaction for the production of colouring foodstuff from purple pitaya (*Hylocereus* sp. [Weber] Britton & Rose)**

Ralf M. Schweiggert · María G. Villalobos-Gutierrez · Patricia Esquivel · Reinhold Carle

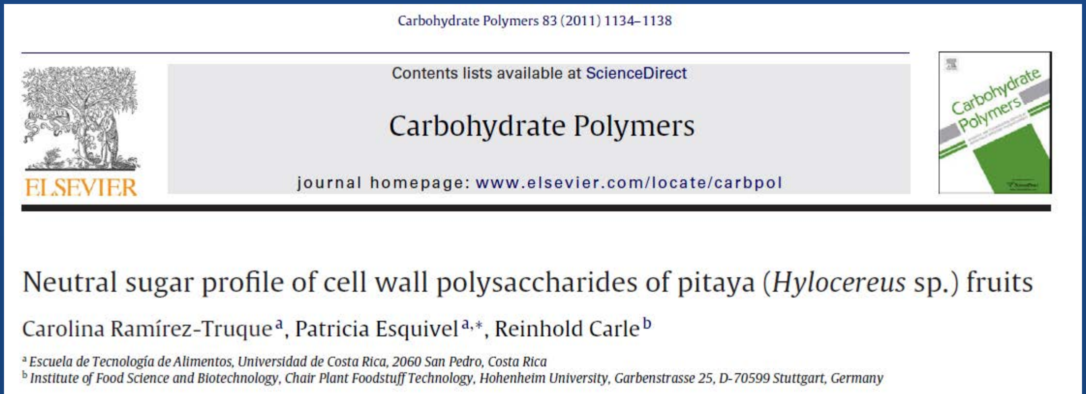
# Composition of cell wall polysaccharides

Mucilage composition affects pigment extraction.

Pectin fractions were mainly composed of arabinose and galactose.

Hemicellulose fraction consists mainly of glucose, xylose and galactose.

Viscosity might not be highly attributed to pectin


Carbohydrate Polymers 83 (2011) 1134–1138

Contents lists available at ScienceDirect

Carbohydrate Polymers

journal homepage: www.elsevier.com/locate/carbpol

Neutral sugar profile of cell wall polysaccharides of pitaya (*Hylocereus* sp.) fruits

Carolina Ramírez-Truque[a], Patricia Esquivel[a,*], Reinhold Carle[b]

[a] *Escuela de Tecnología de Alimentos, Universidad de Costa Rica, 2060 San Pedro, Costa Rica*
[b] *Institute of Food Science and Biotechnology, Chair Plant Foodstuff Technology, Hohenheim University, Garbenstrasse 25, D-70599 Stuttgart, Germany*

# Characterization of seeds and seed oil

Seeds might be a source of valuable compounds

Seed oil mainly composed by unsaturated fatty acids.

Pitaya seed oil is a valuable source for food, cosmetic and pharmaceutical applications

Chemical characterization of pitaya (*Hylocereus* sp.) seeds

| Component | Percentage (fresh weight base) |
|---|---|
| Moisture | 12.57±0.55 |
| Total carbohydrates | 35.17±1.53 |
| Dietary fiber | 30.23±1.86 |
| Fat | 29.60±0.61 |
| Protein | 20.63±0.55 |
| Ash | 2.10±0.06 |

[1] Average value of triplicate analyses (± standard deviation)

Fatty acid composition of the seed oil

| Fatty acid (FA) | %m/m |
|---|---|
| Palmitic acid C16:0 | 18.18±1.14 |
| Palmitoleic acid C16:1 | 0.32±0.12 |
| Stearic acid C18:0 | 4.87±0.34 |
| Oleic acid C18:1 | 23.86±1.60 |
| *cis*-11-vaccenic acid C18:1 | 4.54±0.63 |
| Linoleic acid C18:2 | 46.61±4.17 |
| Arachidic acid C20:0 | 1.80±0.20 |
| Saturated FA | 24.9 |
| Total unsaturated FA | 75.3 |
| Monounsaturated FA | 28.7 |
| Polyunsaturated FA (C18:2) | 46.6 |

*CyTA – Journal of Food*
Vol. 10, No. 1, February 2012, 78–83
Taylor & Francis
Taylor & Francis Group

**Chemical characterization of Central American pitaya (*Hylocereus* sp.) seeds and seed oil**

**Caracterización química de las semillas y el aceite extraído de las semillas de frutas de pitaya (*Hylocereus* sp.) cultivadas en Centroamérica**

M.G. Villalobos-Gutiérrez[a], R.M. Schweiggert[b], R. Carle[b] and P. Esquivel[a]*

# Potential valorization of pitahaya fruit pericarp

Flow curves of 1% solutions of commercial thickeners showed high similarity to a 5% solution of pitaya AIR, thus indicating the requirement of further purification of the pitaya AIR

Food Hydrocolloids 35 (2014) 557–564

Contents lists available at ScienceDirect

Food Hydrocolloids

journal homepage: www.elsevier.com/locate/foodhyd

ELSEVIER

Characterization of cell wall polysaccharides of purple pitaya (*Hylocereus* sp.) pericarp

CrossMark

Alexander Montoya-Arroyo[a,1], Ralf M. Schweiggert[b], María-Lourdes Pineda-Castro[a], Martin Sramek[c], Reinhard Kohlus[c], Reinhold Carle[b], Patricia Esquivel[a,*]

[a] *Escuela de Tecnología de Alimentos, Universidad de Costa Rica, 2060 San Pedro, Costa Rica*
[b] *Institute of Food Science and Biotechnology, Plant Foodstuff Technology, Hohenheim University, Garbenstrasse 25, D-70599 Stuttgart, Germany*
[c] *Institute of Food Science and Biotechnology, Food Process Engineering, Hohenheim University, Garbenstrasse 25, D-70599 Stuttgart, Germany*

UCR

# Third step: selection, breeding and having enough planting material
# Propagation

# Pitaya propagation

Clonal propagation is preferred

Plants from seeds have a long juvenile period

Clonal propagation usually through cuttings from field plants

Less efficient due to the size of the cuttings and the low multiplication rate

# In vitro propagation of pitaya

Advantages:

- Less damage to the plants
- Less bulky
- Higher propagation rate

In Vitro Cell.Dev.Biol.—Plant (2012) 48:469–477
DOI 10.1007/s11627-012-9439-y

MICROPROPAGATION

**_In vitro_ propagation of purple pitahaya (_Hylocereus costaricensis_ [F.A.C. Weber] Britton & Rose) cv. Cebra**

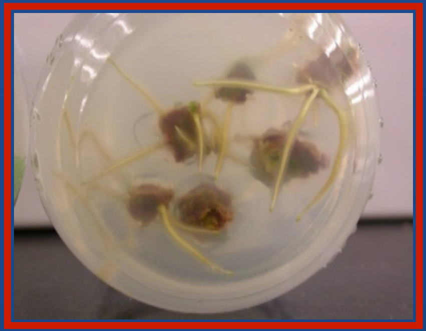
María Viñas • Mainor Fernández-Brenes •
Alvaro Azofeifa • Víctor M. Jiménez

**Field plants**

**Greenhouse plants**

**New shoots**

**Rooting**



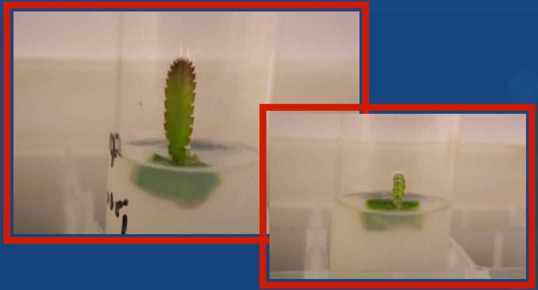
**Acclimatization**

**Disinfection**

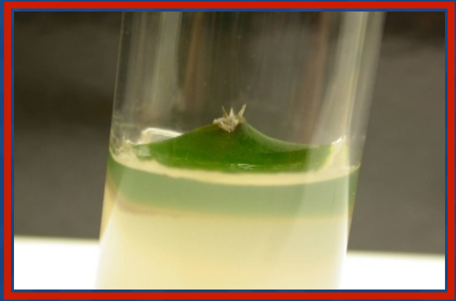
A disinfection protocol, producing low damage to the explants and useful for different genotypes was developed.

**In vitro development**

**Bud sprouting**



**In vitro inoculation**



# Seed germination and storage

Few studies on pitaya seed germination and behavior.

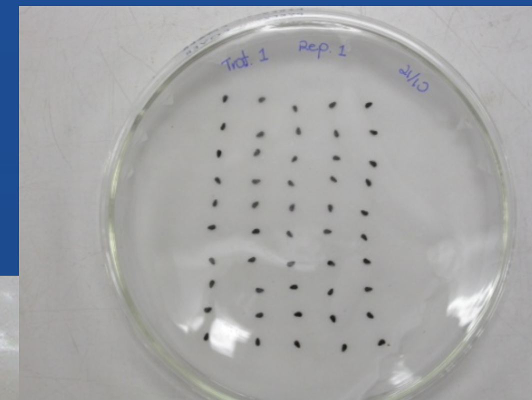
In spite of mentioned drawbacks, propagation through seeds could be important for:

- Breeding programs
- Conservation of genetic resources

Adequate germination and storage conditions were established for pitaya seeds.

Tested:

- For germination: temperature, light regime and extraction method
- For storage: temperature, in/out fruit



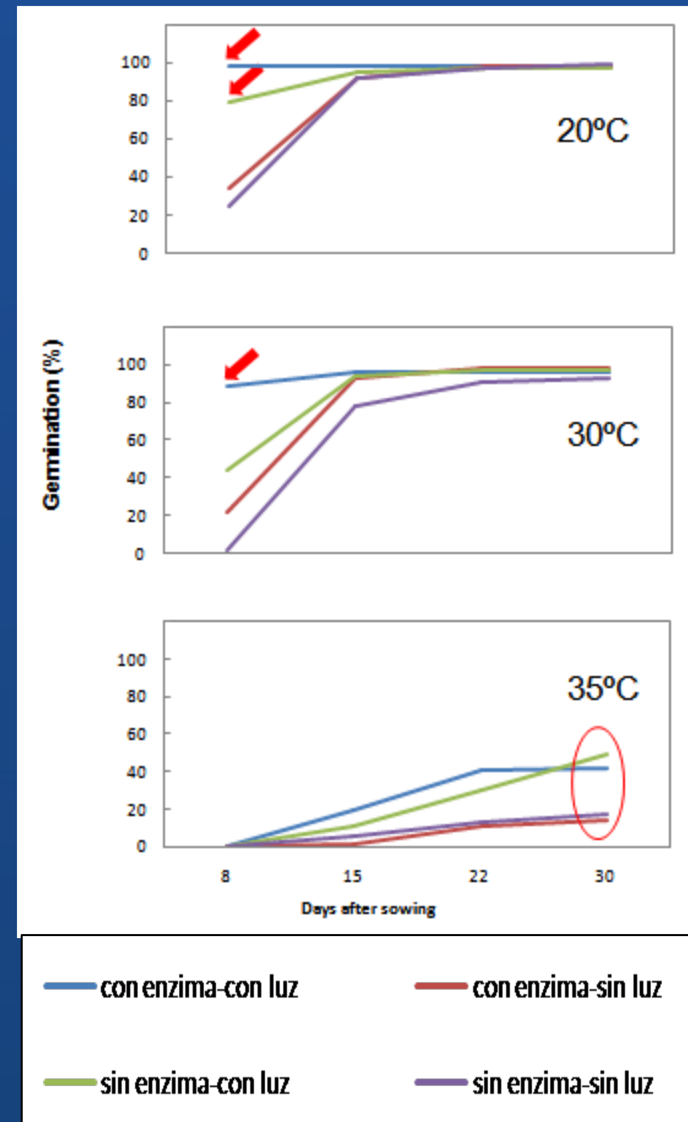
# Seed germination

Lower germination at 35°C.

Light accelerated germination at 20 and 30°C.

Plantlets in absence of light died at higher rates.

Enzymatic separation of seeds: lower contamination levels.



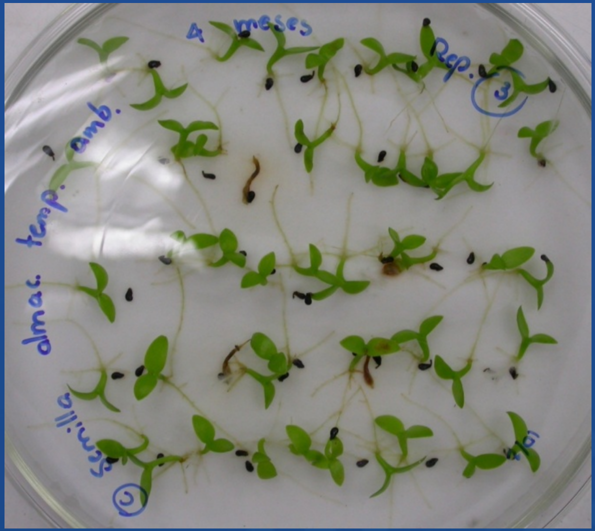
# Seed storage

Seeds could be stored for up to four months at room temperature.

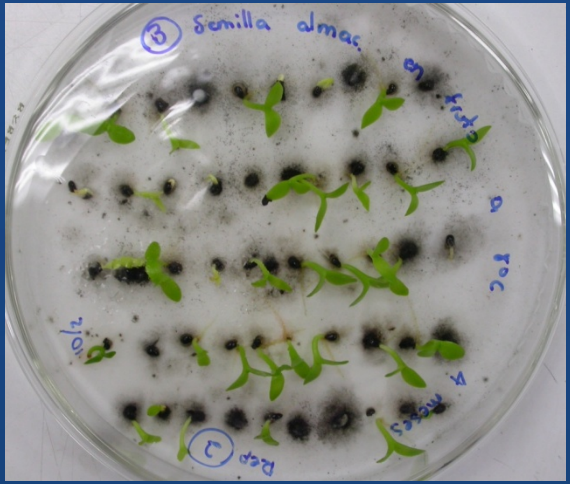
At 4°C germination rate was lower.

Seeds from stored fruits germinated well after four months, but accompanied by microorganism growth.

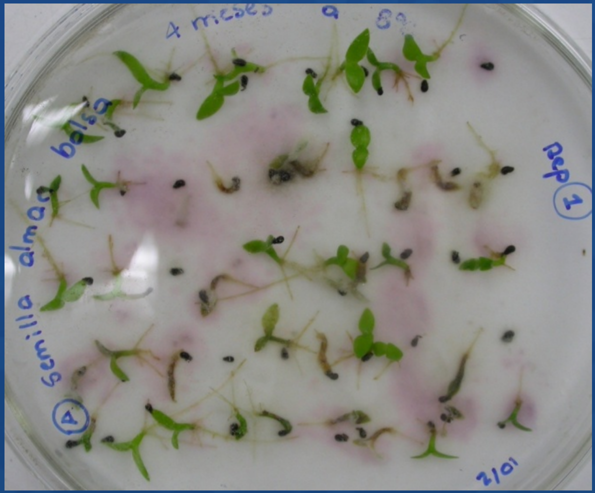
**Room temperature**



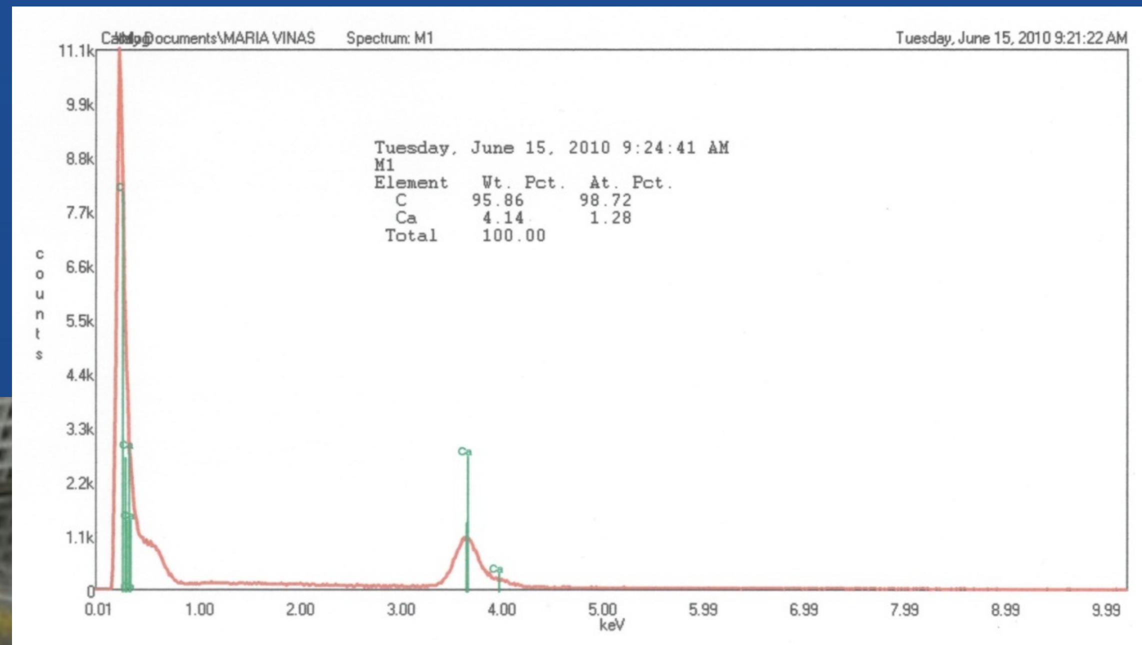

**Seeds from stored fruits**




**4°C**



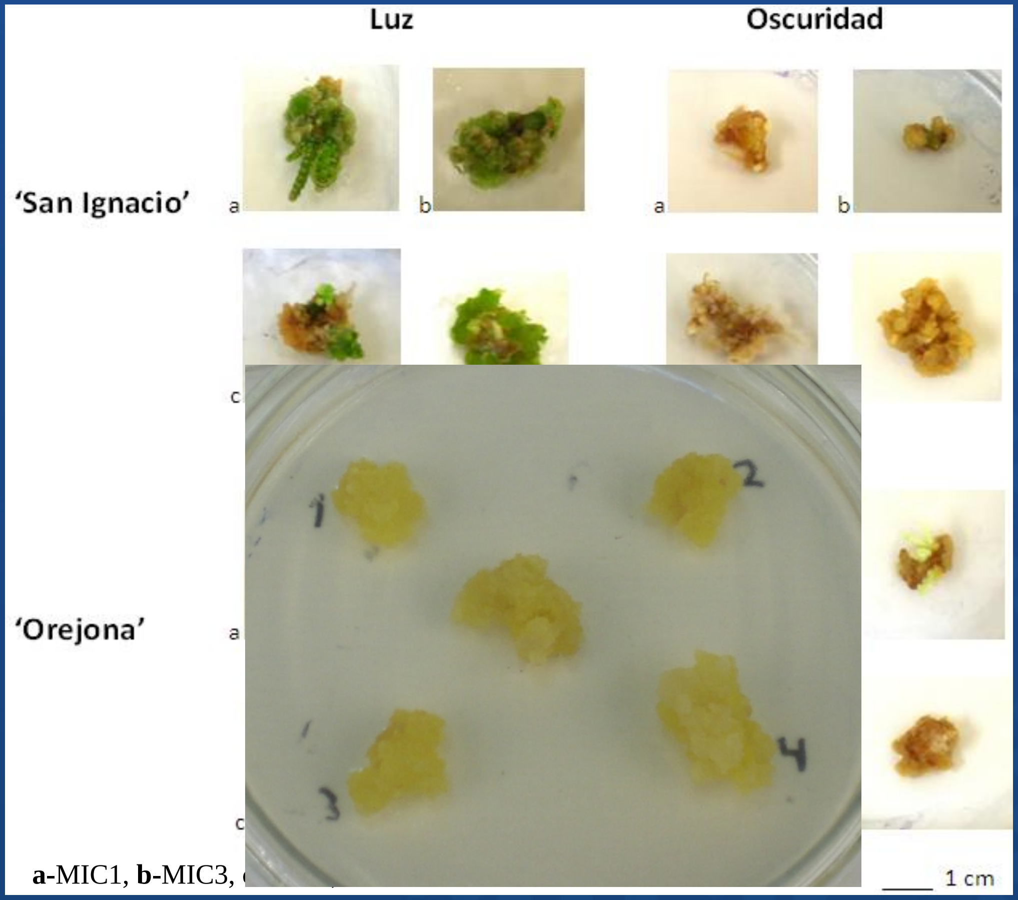
# Fourth phase: additional studies
# Other approaches





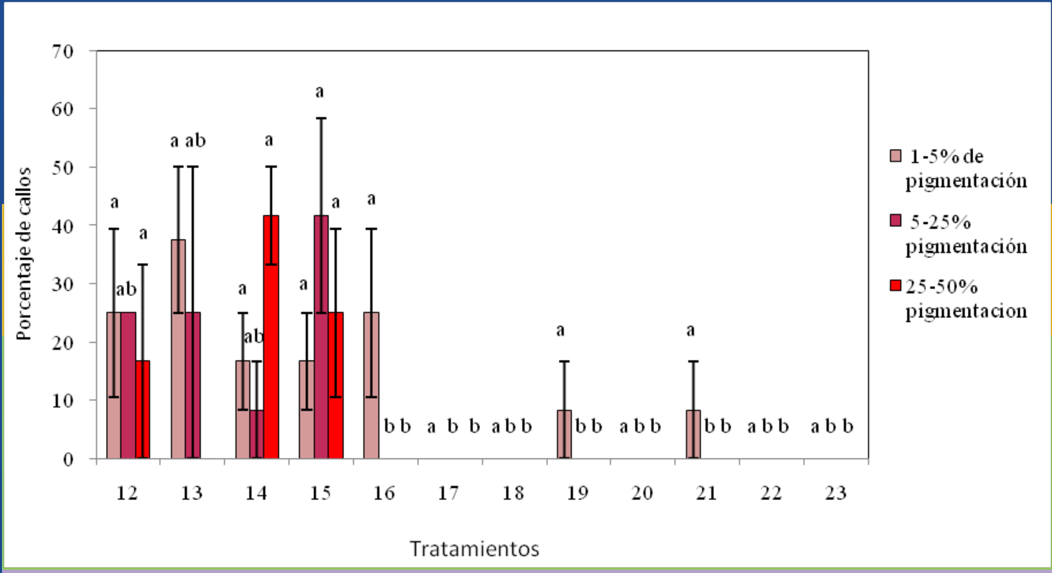
# Development of callus cultures

- Callus
  - Potential source of pigments
  - Fewer problems with mucilage
  - Model to study synthesis
    - Biochemical pathways
    - Effect of elicitors
- Not reported previously in *Hylocereus*
- Several combinations of PGRs were tested with various results
- Cultures grew well but did not show any color development



# Use of elicitors to induce color

- Several biotic and abiotic elicitors were tested
- Best results were obtained with some fungal extracts
- However, pigmentation is still low


| | |
|---|---|
| $T_{12}$- Extracto de micelio *Fusarium* (1% m/v) | Savitha *et al.* (2006) |
| $T_{13}$- Filtrado de medio de cultivo de *Fusarium* (YpSs) (5% v/v) | Savitha *et al.* (2006) |
| $T_{14}$- Extracto de micelio de hongo 1 (1% m/v) | Savitha *et al.* (2006) |
| $T_{15}$- Filtrado de micelio de hongo 1 (YpSs) (5% v/v) | Savitha *et al.* (2006) |
| $T_{16}$- Control de filtrado (YpSs) (5% v/v) | Savitha *et al.* (2006) |
| $T_{17}$- Extracto de *Spirulina* (100 µg/ml) (cápsula comercial BioLand) | Ramachandra *et al.* (2001), Hanagata *et al.* (1994) |
| $T_{18}$- Extracto de *Haematococcus* + *Chlorella* (100 µg/ml) | Ramachandra *et al.* (2001), Hanagata *et al.* (1994) |
| $T_{19}$- Extracto de *Chlorella* (100 µg/ml) | Ramachandra *et al.* (2001), Hanagata *et al.* (1994) |
| $T_{20}$- Sacarosa (10 g/l) + Manitol (5 g/l) | Girod & Zrÿd (1991) |
| $T_{21}$- Sacarosa (10 g/l) + Manitol (10 g/l) | Girod & Zrÿd (1991) |
| $T_{22}$- BAP (0,7 mg/l) | -- |
| $T_{23}$- BAP (7 mg/l) | -- |
| $T_{24}$- Hongo 1 (no determinado) vivo en el medio (luz) | -- |
| $T_{25}$- Hongo 2 (no determinado) vivo en el medio (luz) | -- |
| $T_{26}$- Cambio de temperatura a 22ºC (luz) | -- |
| $T_{27}$- Cambio de temperatura : 4ºC 2 días y luego 22ºC (luz) | -- |
| $T_{28}$- Carbón activado (luz) (1 mg/l) | -- |

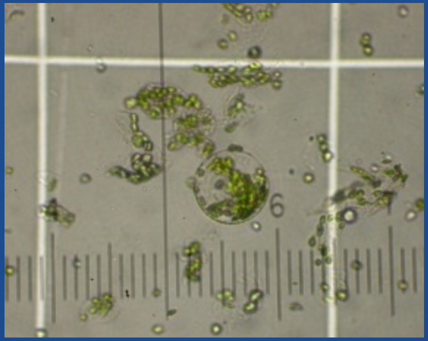
# Protoplasts in *Hylocereus*

- Protoplasts (cells devoid of the cell wall) are interesting for new genetic combinations
- Pigment pattern is restricted in *Hylocereus* (compared e.g., to *Opuntia*)
- Protoplast fusion might increase color (individual betalains) diversity
- Methods for isolation, culture and regeneration are pre-requisite for fusion experiments.

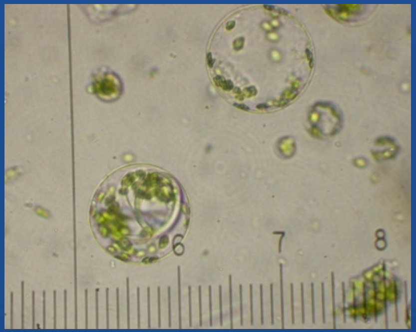
# Protoplasts in *Hylocereus*

- Methodology for protoplast isolation and purification was developed for:
  - In vitro vegetative shoots
  - In vitro roots
  - Shoots from greenhouse plants
  - Callus cultures

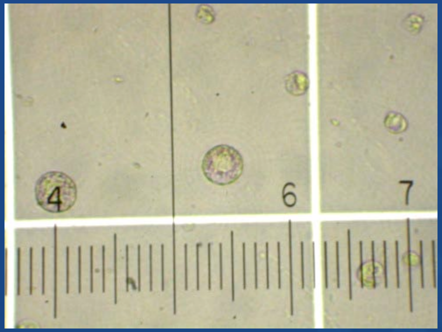
- Microcallus could be induced up to now only from protoplasts of callus cultures



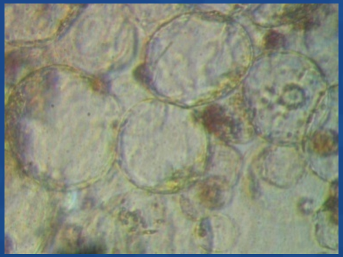
Protoplasts from in vitro shoots



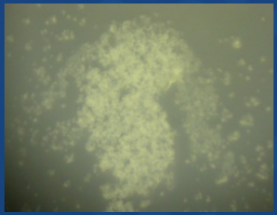
Protoplasts from greenhouse plants

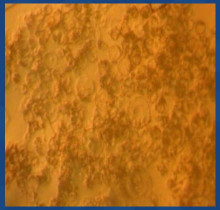


Protoplasts from in vitro roots



Protoplasts from callus cultures





Microcalluses

# Analysis of crystals

- Damage to the protoplasts might be related to crystals
- Cactus species are known for containing calcium oxalate crystals
- Health minor concerns:
  - Teeth damage
  - Irritation
- Localization and characteristics of crystals
- Tissues:
  - In vitro vegetative shoots
  - Greenhouse stems
  - Fruit pulp
  - Fruit flesh

**Damaged protoplasts and crystals**

# Analysis of crystals

- Damage to the protoplasts might be related to crystals
- Cactus species are known for containing calcium oxalate crystals
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- Localization and characteristics of crystals

**Damaged protoplasts and crystals**

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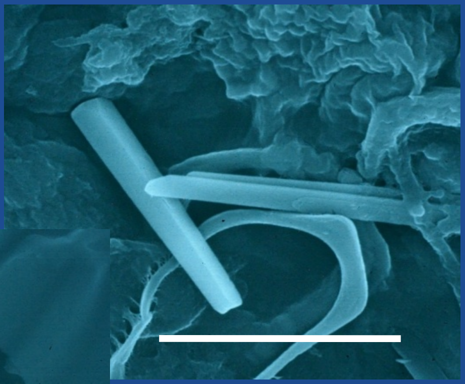
Occurrence and characterisation of calcium oxalate crystals in stems and fruits of *Hylocereus costaricensis* and *Selenicereus megalanthus* (Cactaceae: Hylocereeae)

María Viñas[a,1], Víctor M. Jiménez[a,b,*]

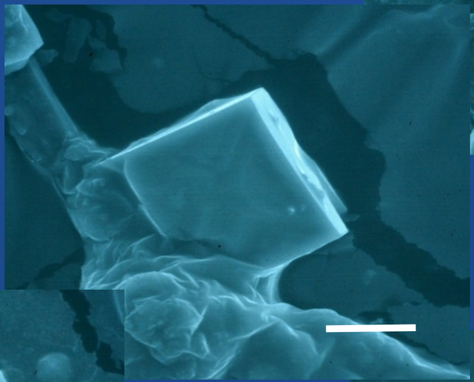
[a] CIGRAS and CIEMic, Universidad de Costa Rica, 2060 San Pedro, Costa Rica
[b] Food Security Center, University of Hohenheim, 70599 Stuttgart, Germany

# Analysis of crystals

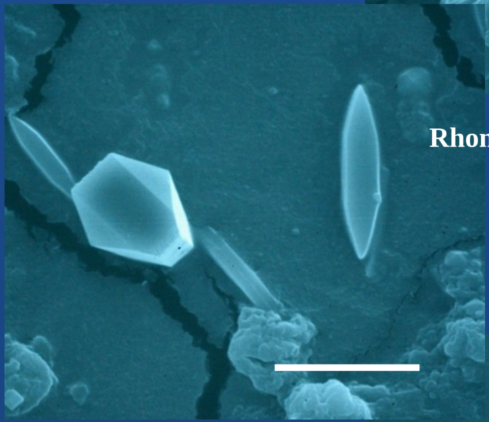
- New method for crystal isolation was developed
- Morphology:
  - Monocyclic styloid
  - Rhomboid-shaped pinacoid
  - Raphide
  - Tetragonal prism
  - Bi-pyramid
- Crystals were found in vegetative tissues and in fruit peels (not in the pulp)
- Monohydrated and dihydrated were found together (rare in the plant kingdom)



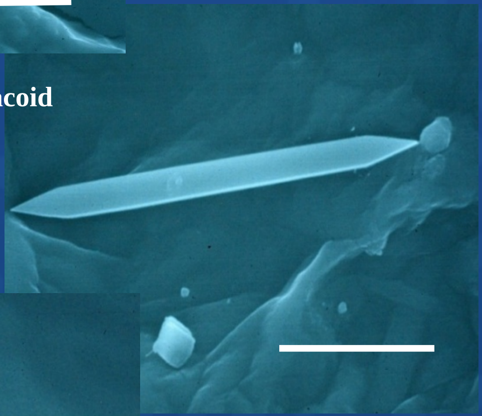
Monocyclic styloid



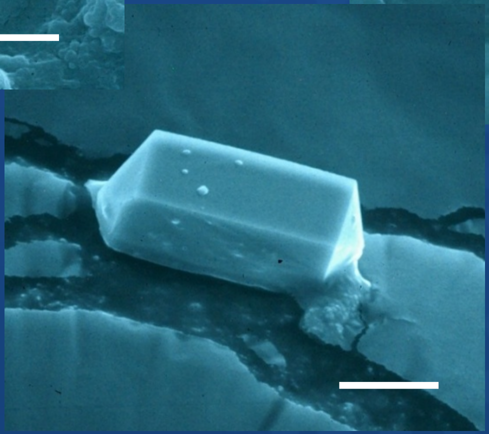
Rhomboid-shaped pinacoid



Bi-pyramid



Raphide



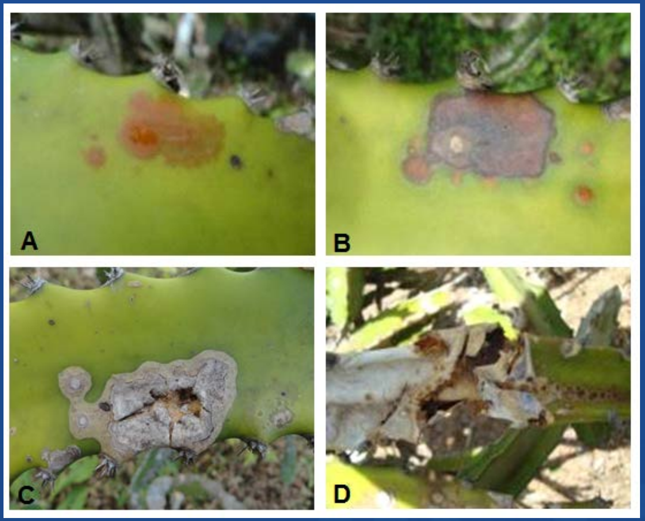
Tetragonal prism

# Diseases

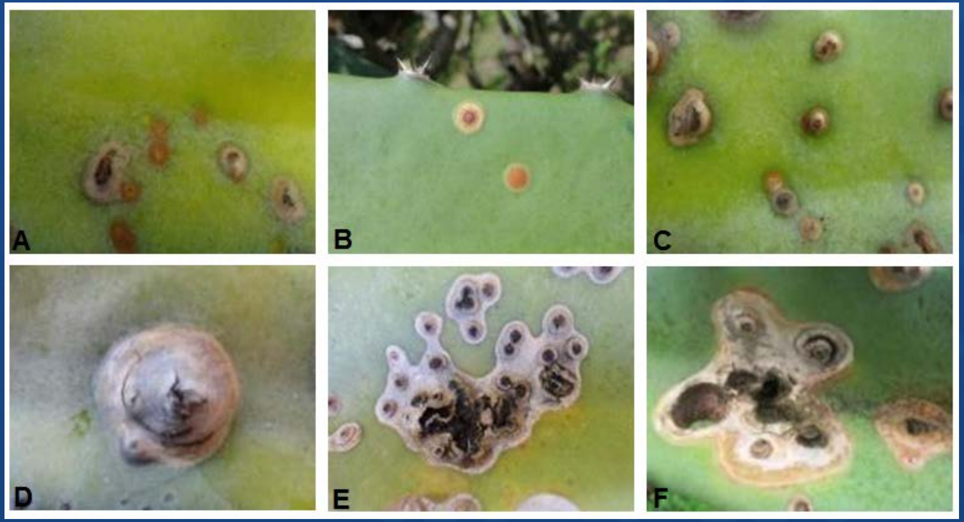
- Diseases are not very evident in plants growing in the wild
  - High diversity
  - Low plant density

# Diseases

- Diseases are not very evident in plants growing in the wild
  - High diversity
  - Low plant density
- Main diseases in Costa Rica:
  - *Neoscytalidium dimidiatum* (Coelomycete, dermatophyte in tropical regions)
  - *Enterobacter hormaechei* (nosocomial pathogen that can infect vulnerable hospitalized patients, plant growth-stimulating bacteria)




*N. dimidiatum*



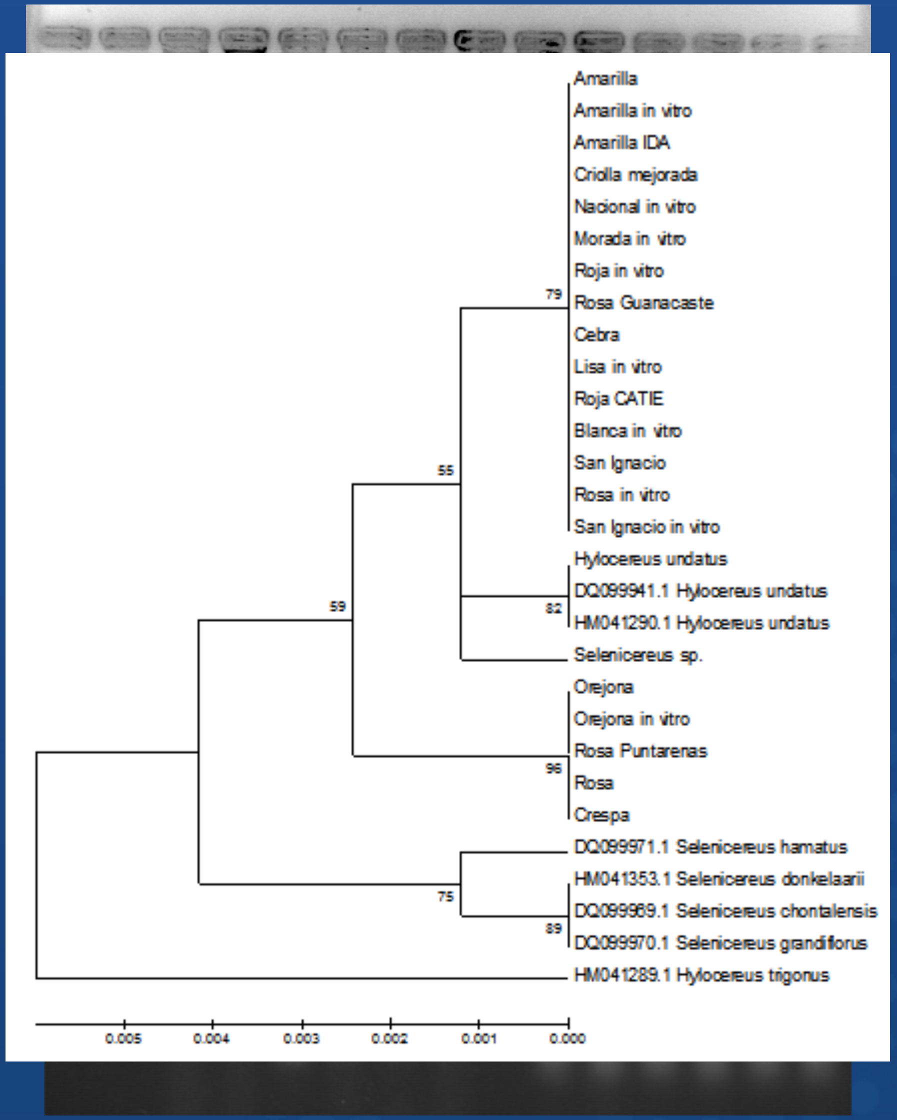

*E. hormaechei*

# Molecular markers

- Taxonomy not clear (descriptors vary according to the environment, many similarities between genotypes)

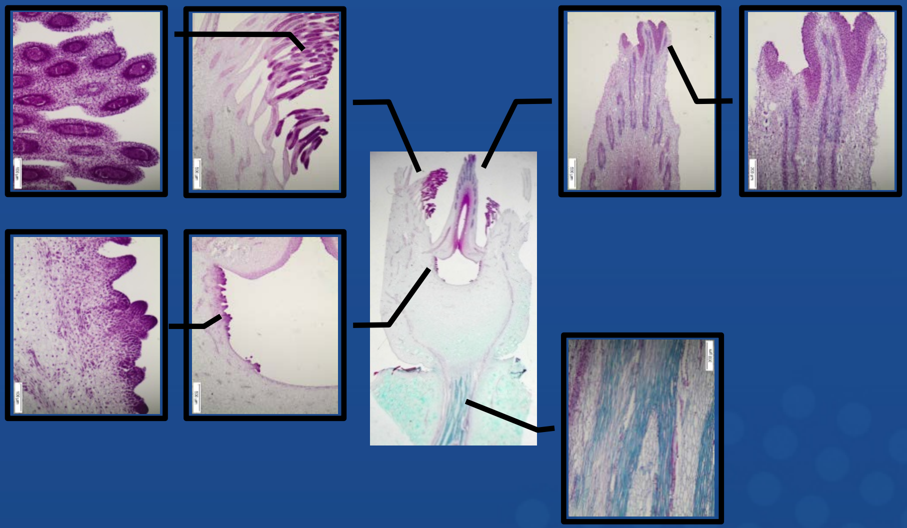
- Approaches:
  - Internal Transcribed Spacer (ITS) region of nuclear ribosomal DNA, a valuable source of evidence on angiosperm phylogeny
  - Chloroplast TrnL intron amplification and digestion

- Achievements:
  - DNA could be successfully isolated (seven protocols evaluated)
  - Nuclear ITS extremely highly variable (not useful)
  - Plastid TrnL allowed separation of genotypes under study in several groups.



# Flowering

- Anatomical characterization of floral bud determination



- Genes participating in flowering determination

- Pitaya putative floral genes partially isolated:
  - Gene fragment with 74% similarity with *APETALA* genes from other species
  - Gene fragment with 72-80% similarity with *LEAFY* genes from other species
  - Other genes under study: *CO*, *FT* and *SOC1*

# Forthcoming

- Conventional breeding
- Improvement of protoplast protocols in *Hylocereus*
- Protoplast fusion experiments
- Biosynthesis of betalains (pathways)
- In vitro conservation systems
- Crop physiology (field)

UCR

# Peach palm fruit – a novel calorie-rich food aiming at reducing vitamin A deficiency in developing countries

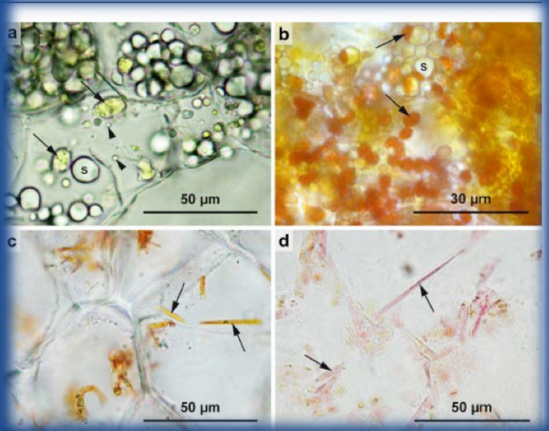
Stefanny Campos-Boza, María Viñas, Paúl Solórzano-Cascante, Dessireé Zerpa-Catanho, Eric Guevara, Patricia Esquivel, Víctor M. Jiménez

- Family Arecaceae
- Cultivated in Central and South America (only in some countries)

- Source of:
  - fruit
  - heart of palm

Fig. 1 Peach palm distribution based on herbaria and genebank data

# Peach palm fruits bear enormous nutritional potential




- High energy value → starch, lipids
- Orange-fleshed fruits → total carotenoids comparable to carrot
- Lipid content (2.2-7.0% of FW) exceeds other tropical, carotenoid bearing fruits → mango (0.3% of FW), papaya (0.1% of FW)
- Recommended daily intake of vitamin A → 3-5 orange-fleshed fruits
- Chromoplast morphology + solubility estimations → accumulation of carotenoids in globular chromoplasts, lipid-dissolved
- Improved bioavailability of lipid-dissolved deposited carotenoids


Planta (2014) 240:1037–1050
DOI 10.1007/s00425-014-2121-3

ORIGINAL ARTICLE

# Lipid-dissolved γ-carotene, β-carotene, and lycopene in globular chromoplasts of peach palm (*Bactris gasipaes* Kunth) fruits

**Judith Hempel · Evelyn Amrehn · Silvia Quesada · Patricia Esquivel · Víctor M. Jiménez · Annerose Heller · Reinhold Carle · Ralf M. Schweiggert**

# Peach palm

## *Bactris gasipaes* Kunth (Arecaceae)

- The two largest germplasm banks in the world are located in Costa Rica:
  - ✓ Instituto Nacional de Innovación y Transferencia de Tecnología (INTA).
  - ✓ Centro Agronómico Tropical de Investigación y Enseñanza (CATIE).
- These and other collections are endangered.

## Problems

- Ageing and death of the plants.
- Vandalism.
- Absence of a reliable methodologies for clonal propagation of peach palm.

## Solution

- Plant tissue culture for clonal propagation and genotype conservation and rescue.

# Peach palm tissue culture

A: Rough dissection
B: Disinfection
C: Fine dissection
D: Initial culture
E: Growth and differentiation
F: Development of first embryos
G: Development of additional embryos and callus
H: Embryo proliferation
I: Embryo differentiation
J: Plantlet development and root induction
K: Separation of individual plants
L: Plant growth and development
M: Plant hardening
N: Plant ready for acclimatization
O: Acclimatized plant (greenhouse)