FAPESP WEEK GERMANY

March 25-26th, 2025

FAPESP SÃO PAULO RESEARCH FOUNDATION

DFG Deutsche Forschungsgemeinschaft

FoRC FOOD RESEARCH CENTER

napan

UNVEILING BIOACTIVE POLYSACCHARIDES: FROM TECHNOLOGICAL PROSPECTION TO BIOLOGICAL EFFECTS IN HUMANS

@joaopaulofabi

JOÃO PAULO FABI, Ph.D.

ASSOCIATE PROFESSOR

DEPARTMENT OF FOOD SCIENCE AND EXPERIMENTAL NUTRITION

FACULTY OF PHARMACEUTICAL SCIENCES

THE UNIVERSITY OF SÃO PAULO

jpfabi@usp.br

FAPESP WEEK GERMANY

March 25-26th, 2025

FAPESP SÃO PAULO RESEARCH FOUNDATION

DFG Deutsche Forschungsgemeinschaft

FoRC

FOOD RESEARCH CENTER

Centro de Pesquisa em Alimentos

RIDC

RESEARCH, INNOVATION AND DISSEMINATION CENTERS

Research, Innovation and Dissemination Centers

Centers | Program RIDC | Opportunities | News | Português

Food Research Center

CEPID 2013-2024

https://cepid.fapesp.br/food-research-center

USP

FAPESP

napan

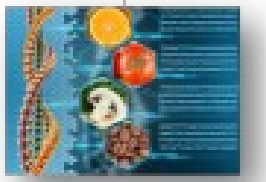
FoRC
FOOD RESEARCH CENTER

Society

Research

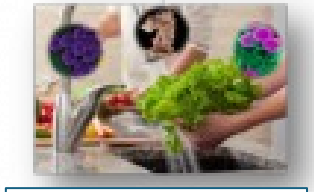
Education and dissemination of knowledge

Technology Transfer



Pilar 1
Food Biological Systems

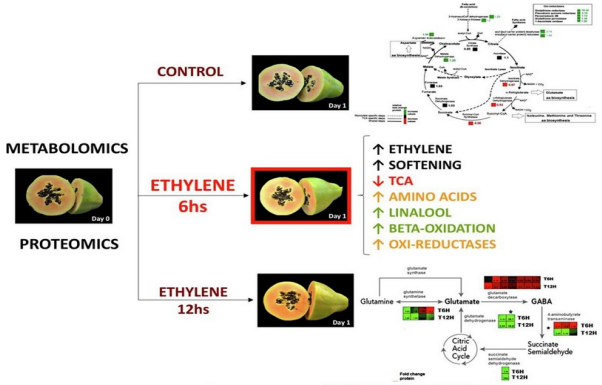
Pilar 2
Food, Nutrition and Health

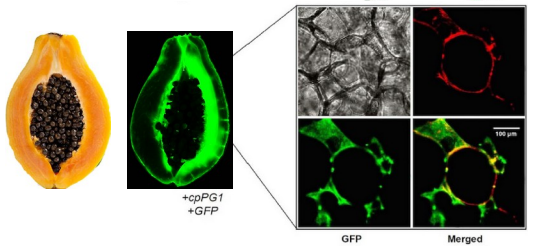


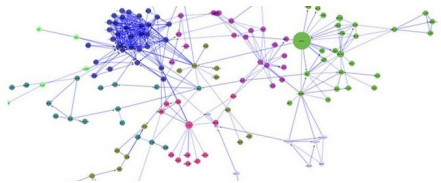
Pilar 3
Food Safety and Quality

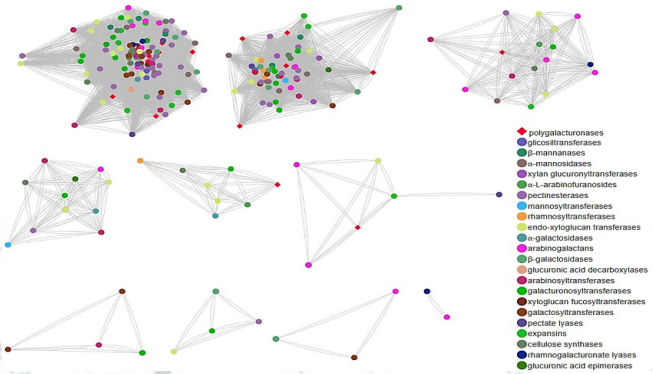
Pilar 4
New Technologies and Innovation

PLANT SCIENCE









POLYSACCHARIDES

BIOLOGICAL

FOOD INGESTION

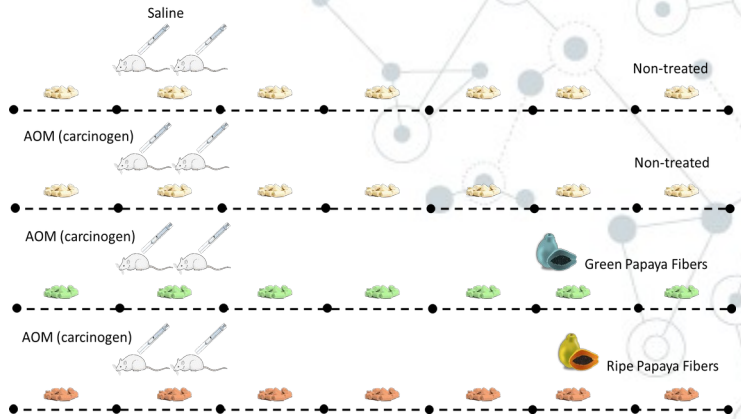
TECHNOLOGICAL

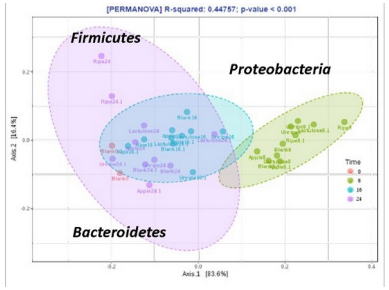
FOOD ISOLATION

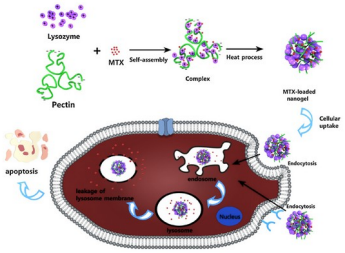
FOOD SUPPLEMENTS

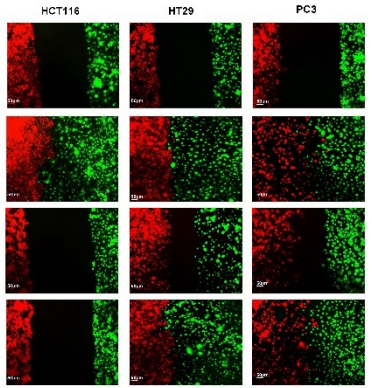
NANO CAPSULES

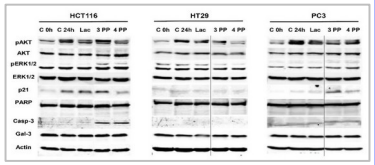
FOOD SCIENCE











HEALTHY LIFESTYLE

Langlois, M., Chandon, P. (2024).
https://doi.org/10.1038/s44271-024-00072-x

EATING HABITS

Dong, HJ., Brain, K., Olsson, M. et al. (2024).
https://doi.org/10.1038/s41598-024-55449-z

Importance of fruits and vegetables

Regularly consumption could lower the risk of cancer death;

Presence of vitamins, minerals, secondary metabolites and **dietary fiber** (**BIOACTIVE COMPOUNDS**).

Prado et al., 2019

Food Fibers as Bioactive Compounds

•Polysaccharides (> 10 U / 20 U) not hydrolyzed by human enzymes

<u>INSOLUBLE</u> (non-fermentable)

<u>SOLUBLE</u> (fermentable)

- ***Soluble (Fermentable) Fibers*** *(Pedrosa and Fabi, 2023)*:
  - **<u>PECTINS</u> / Oligosaccharides / Glycans / Gums**
  - **Increase stool viscosity (satiety);**
  - **Reduces glycemic response and plasma cholesterol;**
  - **Fermentable by the human intestinal microbiota (not all**

PECTINS

Soluble fibers:

- Polysaccharides with High Molecular Weight
  - ➢Biological benefits:
    - ➢***Immunomodulation*** *(Prado et al., 2019)*

- Fermentation by microbiota to SCFAs
  - ➢Biological benefits:
    - ➢***Lower risk of cancer*** *(Pedrosa and Fabi 2023)*

- **Not fermented: local / systemic action**

FAPESP WEEK GERMANY
March 25-26th, 2025

Sustainability and Food

FAPESP SÃO PAULO RESEARCH FOUNDATION
DFG Deutsche Forschungsgemeinschaft

Fibers:

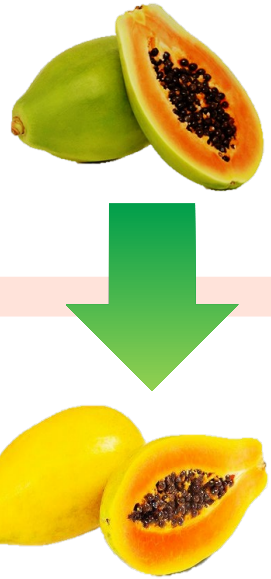
How to prospect bioactive pectins?

Comercial centers:

Juice industry:

Sha SP et al. (2023) 10.3389/fmicb.2023.1260071

TWO PECTIN-RICH FRUITS IN BRAZIL: PAPAYA AND PASSION FRUIT

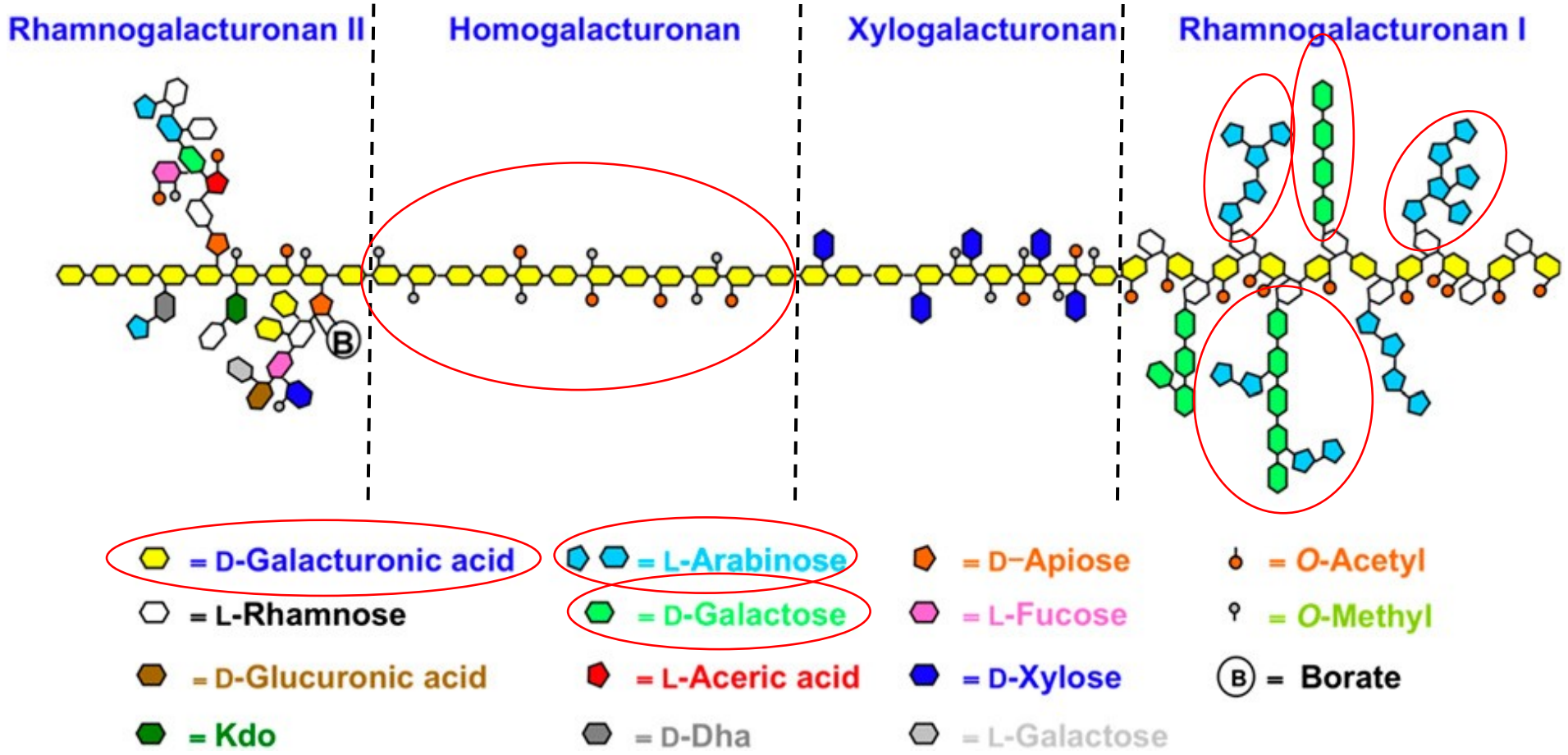


Commercial centers: 4th world producer; 4th most consumed fruit (bananas, apples, oranges); ~ 30% wasted (harvesting, transportation, over-ripening in centers)

Juice industry: 1st world producer; 40% to industry; Peel and mesocarp (albedo) ~ 50% fruit weight

PECTIN STRUCTURE

High Molecular Weight



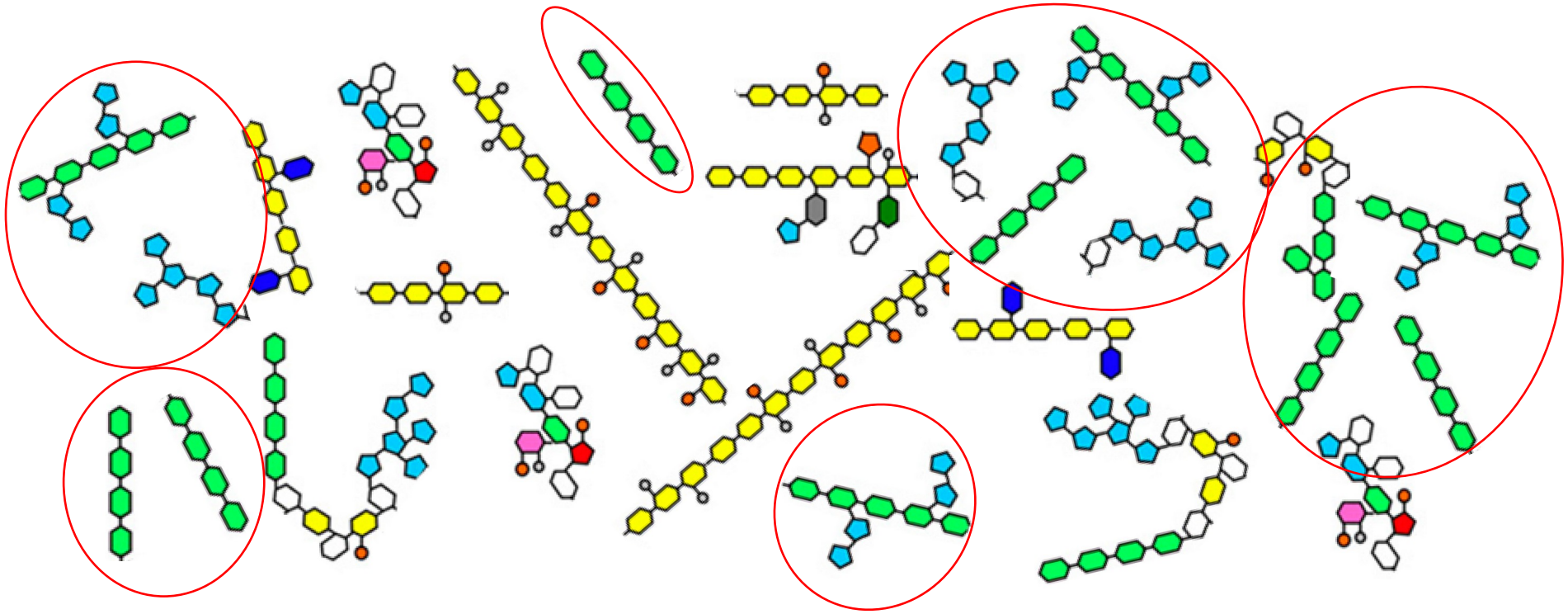
HOW CAN WE IMPROVE THE BIOLOGICAL ACTIVITY?

PECTIN SOLUBILIZATION

- TEMPERATURE
- CHEMICALS
- ENZYMES
- *NATURAL RIPENING*

↓ Molecular Weight

↑ Biological Effects



NATURAL PAPAYA RIPENING: PECTIN SOLUBILIZATION?

https://revistapesquisa.fapesp.br/frutos-maduros-por-caminhos-distintos/

OPEN ACCESS Freely available online

PLOS ONE

Analysis of Papaya Cell Wall-Related Genes during Fruit Ripening Indicates a Central Role of Polygalacturonases during Pulp Softening

João Paulo Fabi[1,3]*, Sabrina Garcia Broetto[1], Sarah Lígia Garcia Leme da Silva[1], Silin Zhong[2], Franco Maria Lajolo[1,3], João Roberto Oliveira do Nascimento[1,3]

frontiers in Plant Science | Plant Physiology

SECTION ABOUT ARTICLES RESEARCH TOPICS FOR AUTHORS EDITORIAL BOARD ARTICLE ALERTS

< Articles

ORIGINAL RESEARCH ARTICLE

Front. Plant Sci., 27 July 2016 | https://doi.org/10.3389/fpls.2016.01120

Physiological Degradation of Pectin in Papaya Cell Walls: Release of Long Chains Galacturonans Derived from Insoluble Fractions during Postharvest Fruit Ripening

Samira B. R. do Prado[1], Paulo R. Melfi[1], Victor C. Castro-Alves[1], Sabrina G. Broetto[1], Elias S. Araújo[1], João R. O. do Nascimento[1,2,3] and João P. Fabi[1,2,3]*

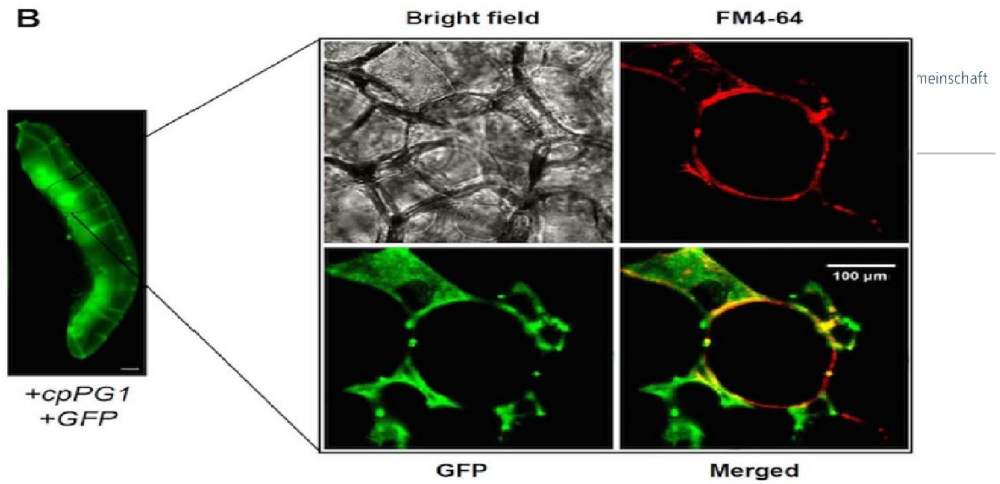
nature plants

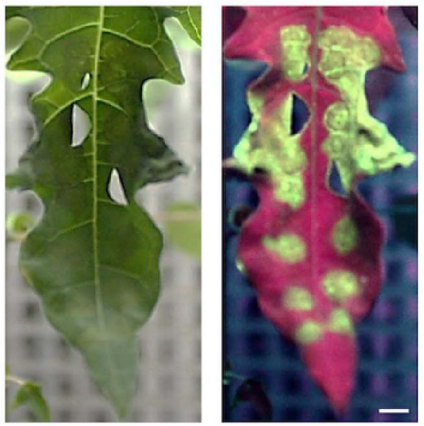
ARTICLES

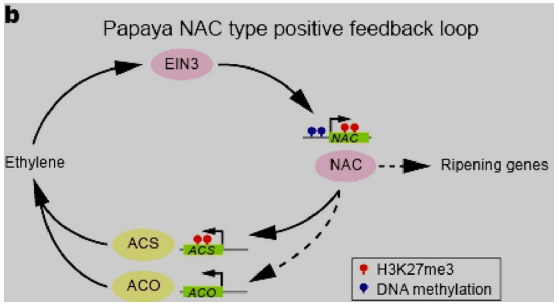
https://doi.org/10.1038/s41477-018-0249-z

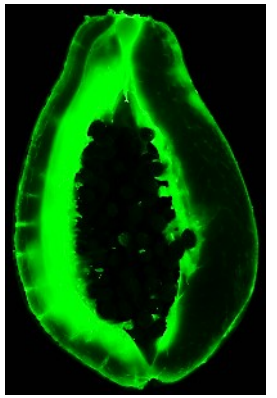
Genome encode analyses reveal the basis of convergent evolution of fleshy fruit ripening

Peitao Lü[1,11], Sheng Yu[1,11], Ning Zhu[1,11], Yun-Ru Chen[1,11], Biyan Zhou[2,11], Yu Pan[3], David Tzeng[1], Joao Paulo Fabi[4], Jason Argyris[5], Jordi Garcia-Mas[5], Nenghui Ye[6], Jianhua Zhang[6], Donald Grierson[7,8], Jenny Xiang[9], Zhangjun Fei[10], James Giovannoni[10] and Silin Zhong[1*]









Fabi et al., 2014; Prado et al., 2017
Lu et al., 2018

Food Research International
Volume 131, May 2020, 108975

Metabolome and proteome of ethylene-treated papayas reveal different pathways to volatile compounds biosynthesis

Roberta Ghedini Der Agopian [a, 1] ✉, João Paulo Fabi [a, b, 1] ✉, Beatriz Rosana Cordenunsi-Lysenko [a, b] ✉

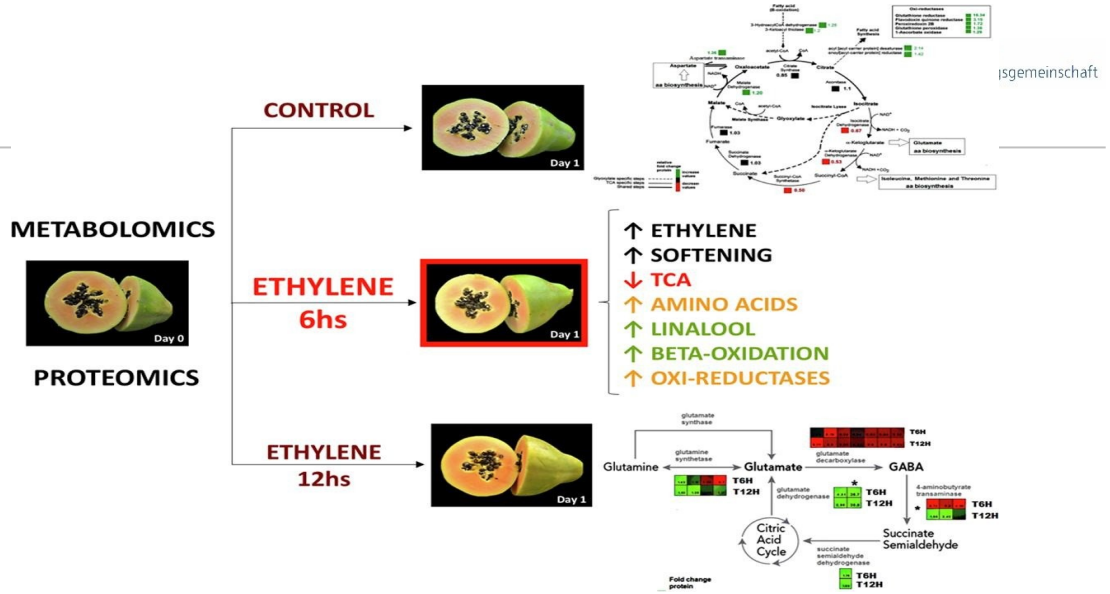
TRANSCRIPTOMICS
PROTEOMICS
METABOLOMICS

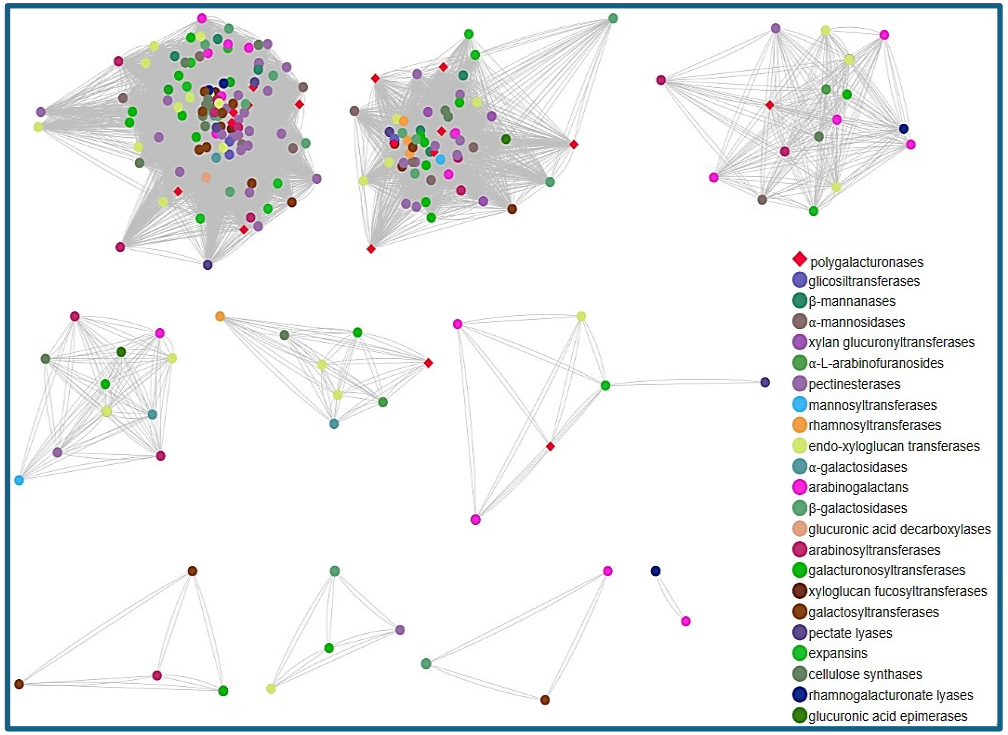
cells
MDPI

Article

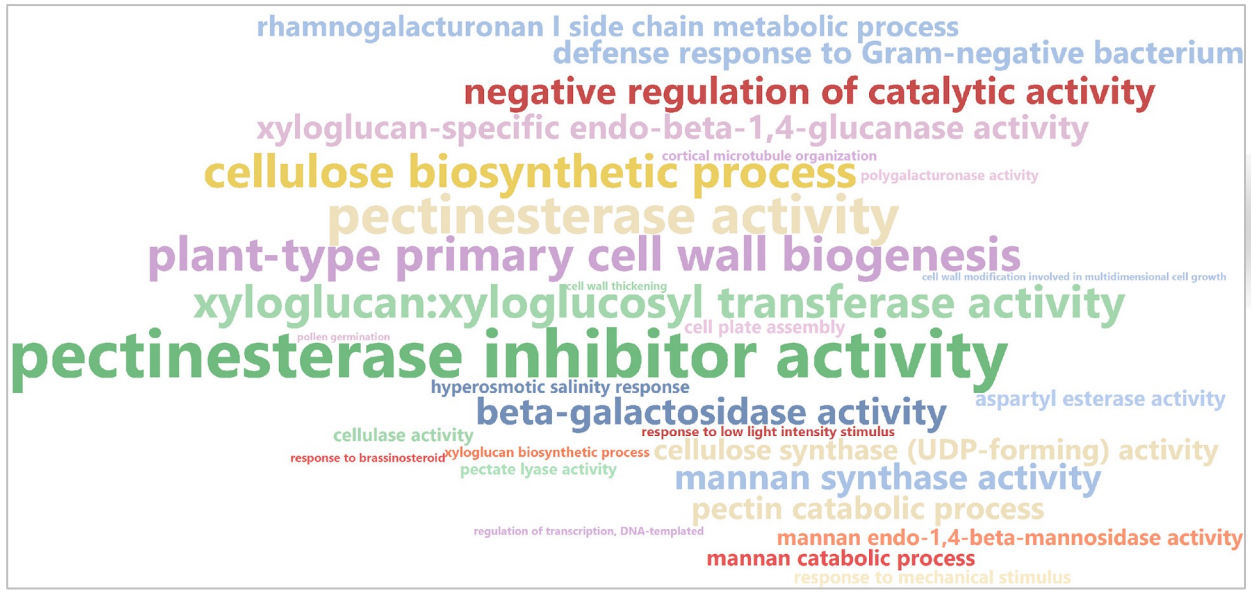
Systems Biology Applied to the Study of Papaya Fruit Ripening: The Influence of Ethylene on Pulp Softening

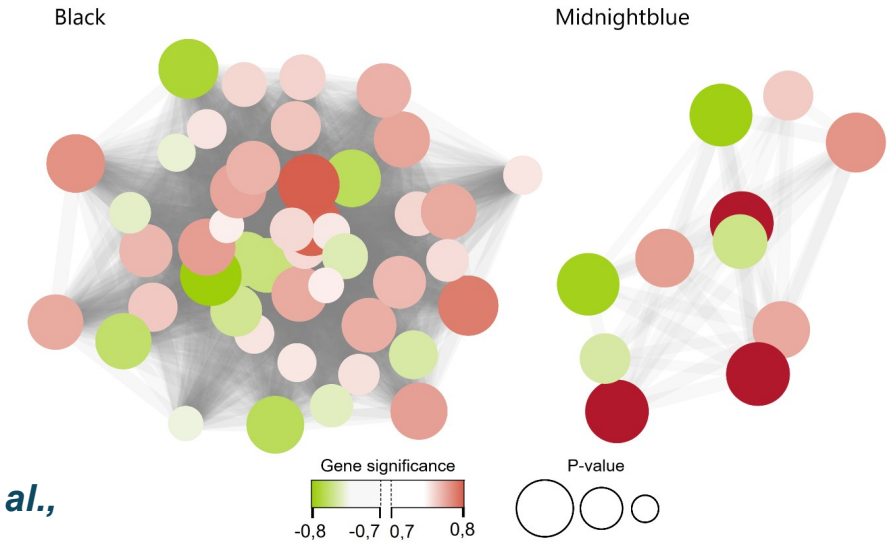
Caroline Giacomelli Soares [1,2], Samira Bernardino Ramos do Prado [1,2], Sónia C. S. Andrade [3] and João Paulo Fabi [1,2,4,*]



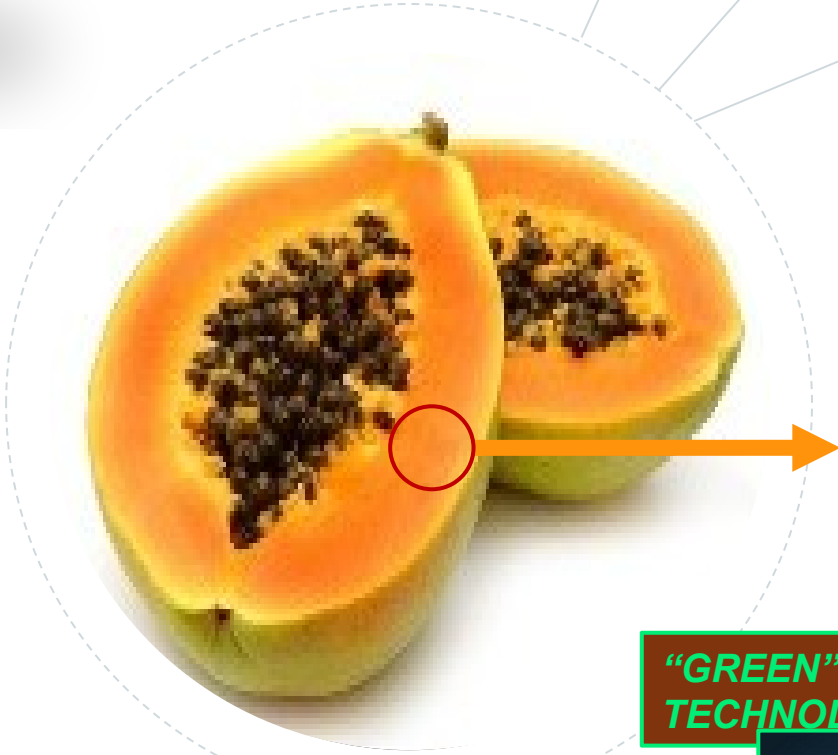


Massive pectin solubilization during ripening: possible bioactive effects of RIPE PECTINS





Soares et al., 2021



PECTIN EXTRACTION FROM PULP

"GREEN" TECHNOLOGY

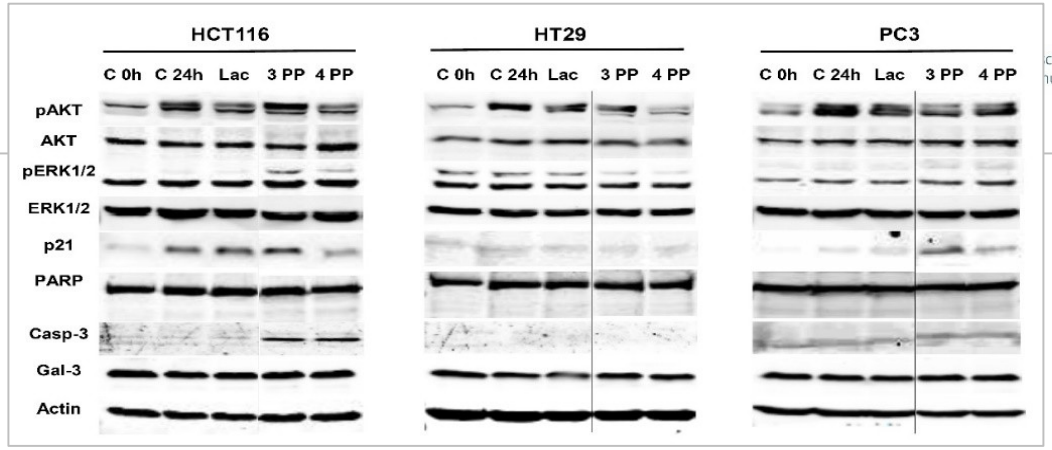
SCIENTIFIC REPORTS

OPEN

Ripening-induced chemical modifications of papaya pectin inhibit cancer cell proliferation

Received: 17 July 2017
Accepted: 13 October 2017
Published online: 29 November 2017

Samira Bernardino Ramos do Prado[1], Gabrielle Fernandez Ferreira[1], Yosuke Harazono[2,3], Tânia Misuzu Shiga[1], Avraham Raz[2], Nicholas C. Carpita[4] & João Paulo Fabi[1,5,6]



International Journal of Biological Macromolecules 126 (2019) 170–178

Contents lists available at ScienceDirect

International Journal of Biological Macromolecules

journal homepage: http://www.elsevier.com/locate/ijbiomac

Chelate-soluble pectin fraction from papaya pulp interacts with galectin-3 and inhibits colon cancer cell proliferation

Samira Bernardino Ramos do Prado [a], Gustavo R.C. Santos [b], Paulo A.S. Mourão [b], João Paulo Fabi [a,c,*]

International Journal of Biological Macromolecules 164 (2020) 2681–2690

Contents lists available at ScienceDirect

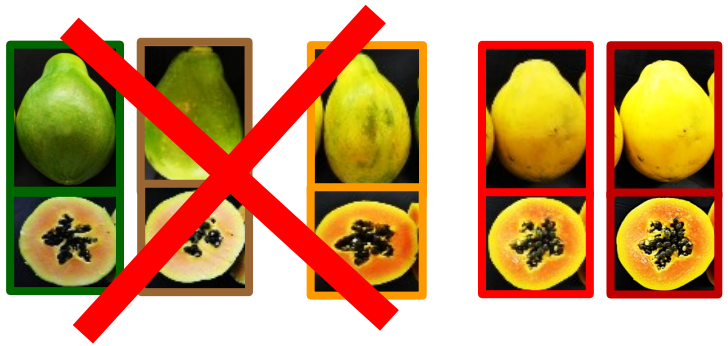
International Journal of Biological Macromolecules

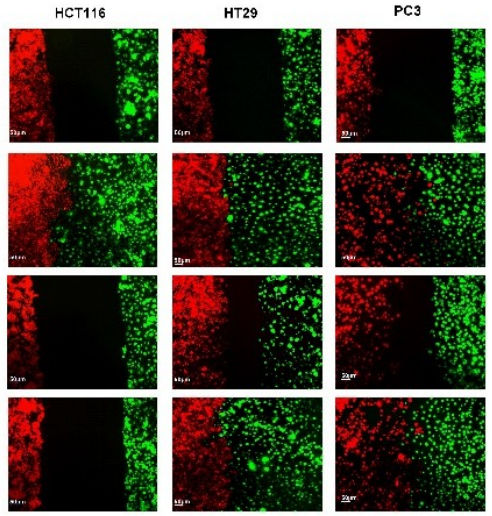
journal homepage: http://www.elsevier.com/locate/ijbiomac

The acid and neutral fractions of pectins isolated from ripe and overripe papayas differentially affect galectin-3 inhibition and colon cancer cell growth

Lucas de Freitas Pedrosa [a], Rodrigo Guimarães Lopes [a], João Paulo Fabi [a,b,c,*]

- *In vitro* anticancer activity
- Ripening-dependent
- Structure-dependent





FAPESP WEEK GERMANY

March 25-26th, 2025

Carbohydrate Polymers 331 (2024) 121878

Contents lists available at ScienceDirect

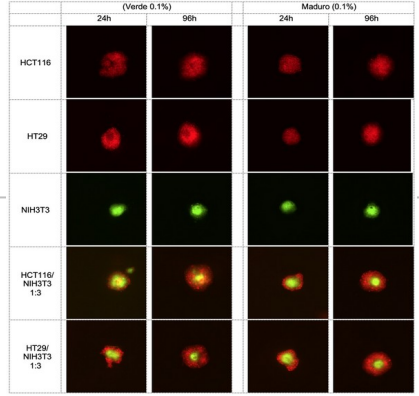
Carbohydrate Polymers

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

Ripe papaya pectins inhibit the proliferation of colon cancer spheroids and the formation of chemically induced aberrant crypts in rats colons

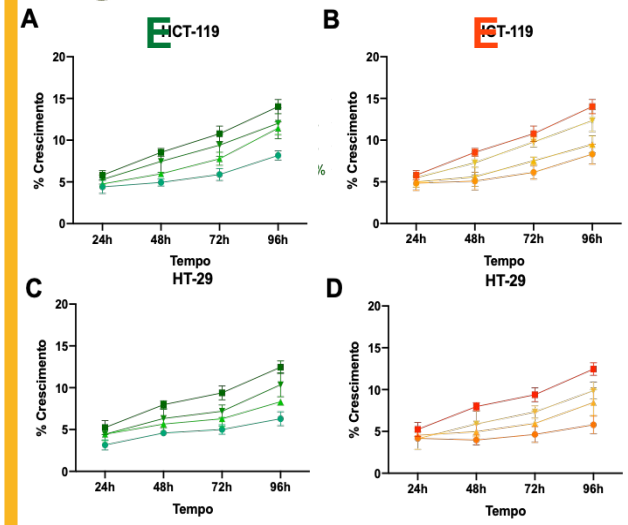
Janaina L.S. Donadio [a,b,1], Samira Bernardino Ramos do Prado [c,1], Caroline Giacomelli Soares [a], Rodrigo Invernort Tamarossi [a], Renato Heidor [a], Fernando Salvador Moreno [a], João Paulo Fabi [a,b,d,*]

Deutsche Forschungsgemeinschaft

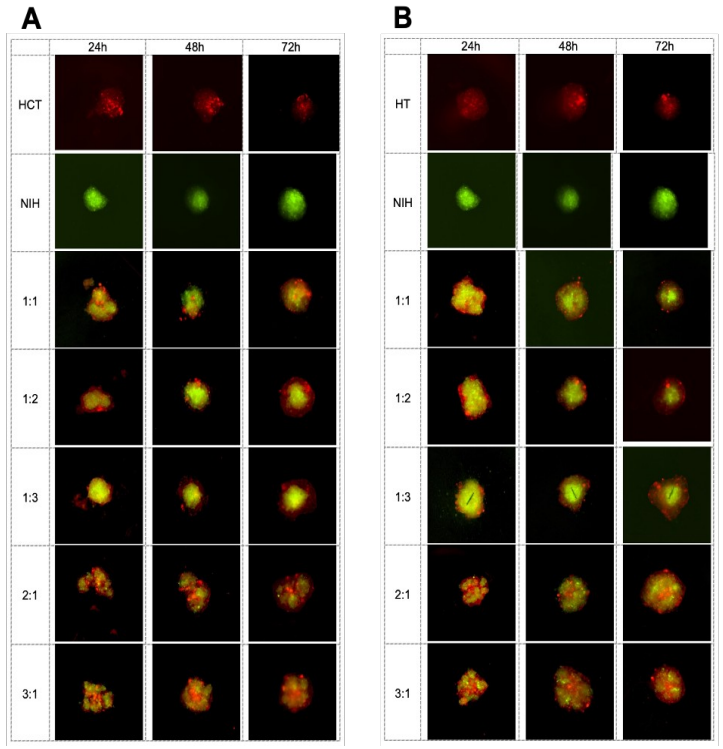


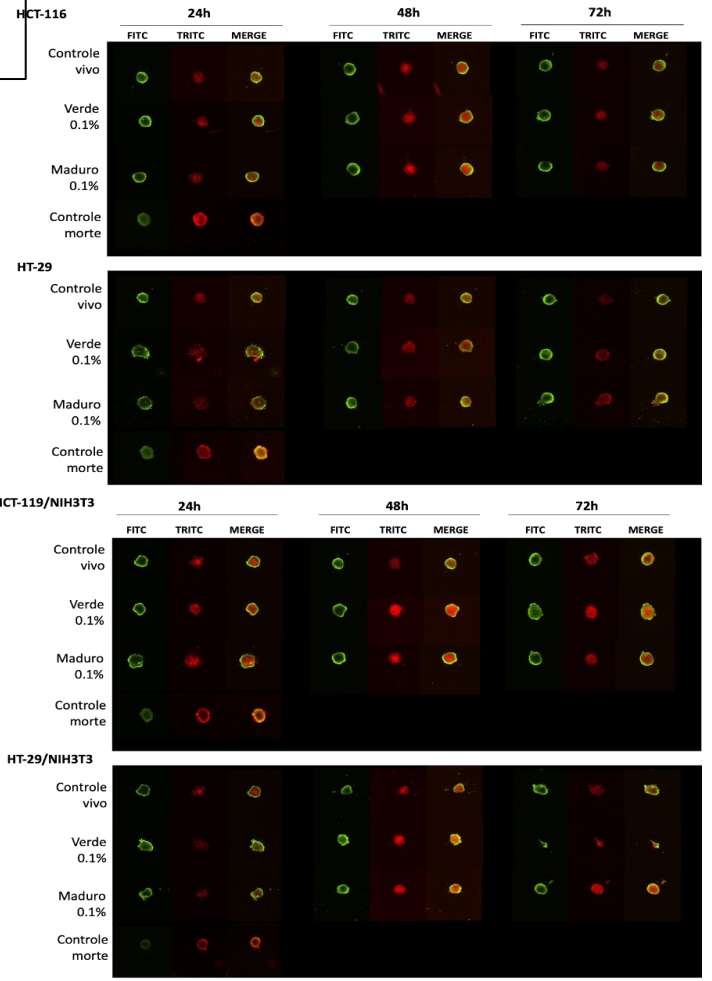
3D COLON CANCER CELLS TREATMENT WITH PECTINS

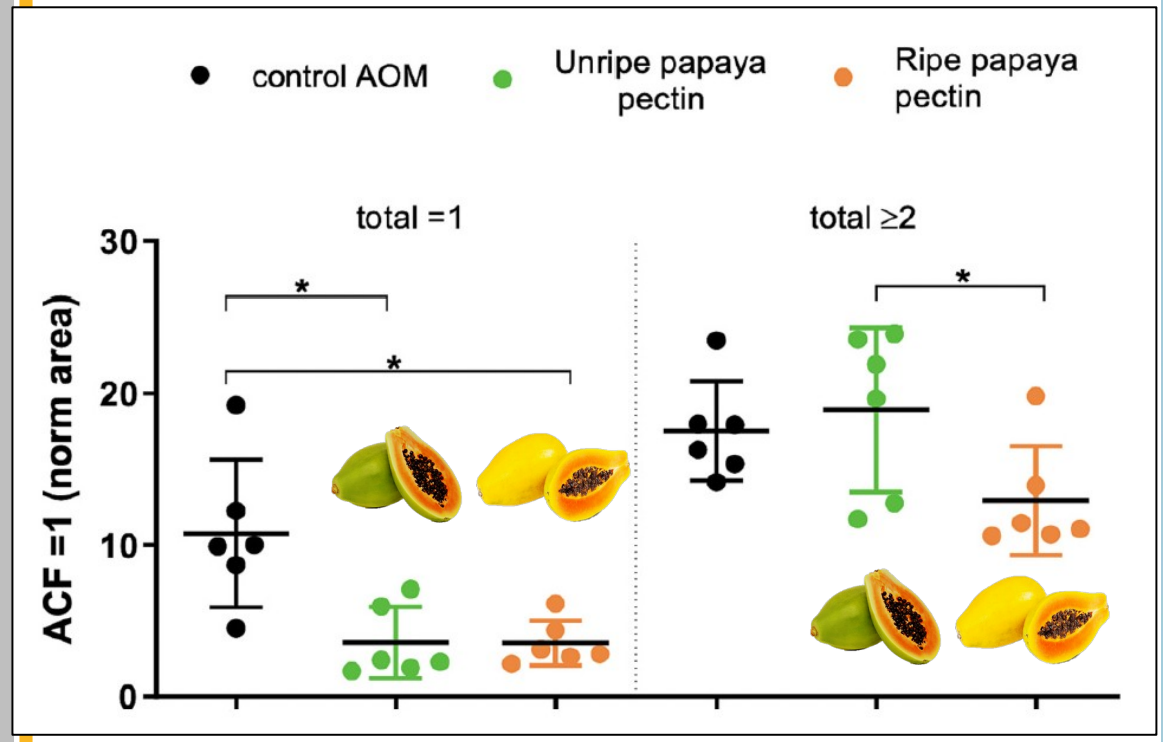
UNRIPE

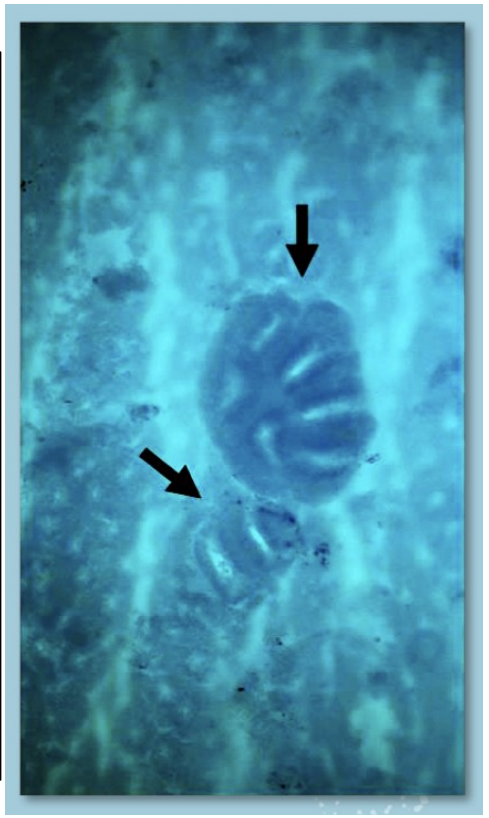


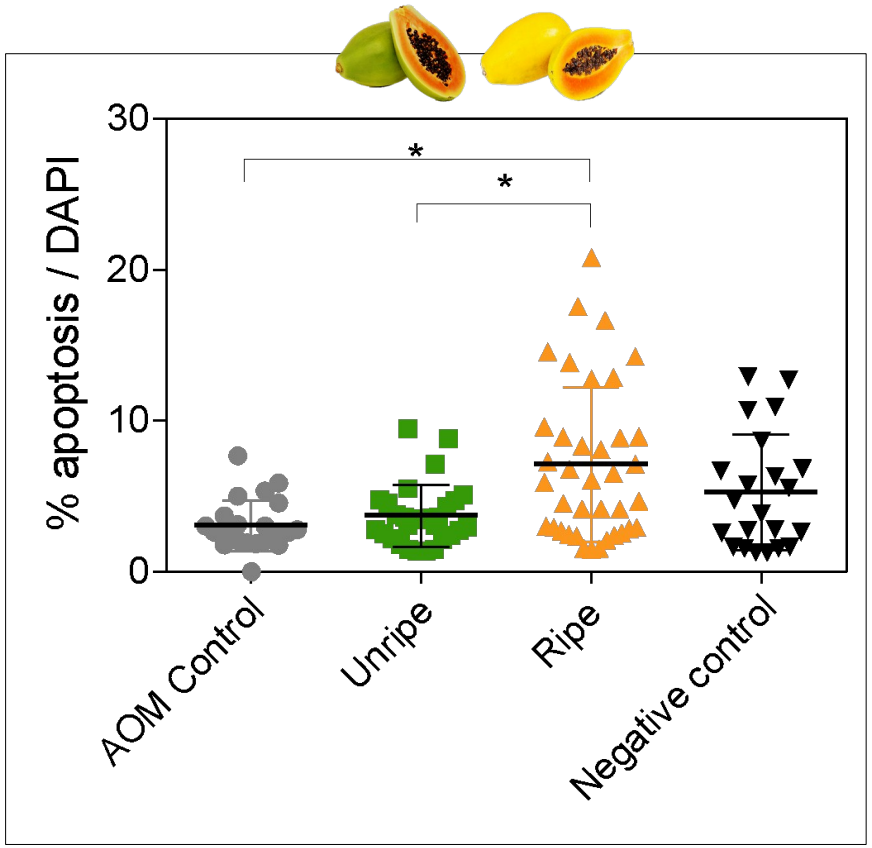
RIPE



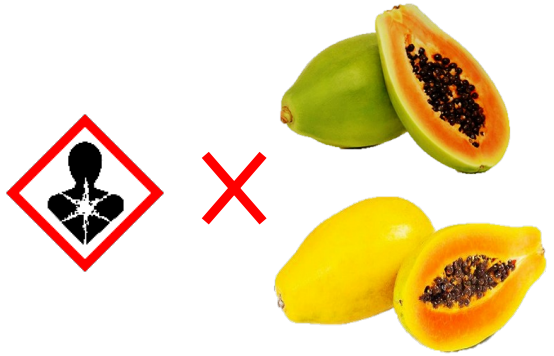



control AOM
Unripe papaya pectin
Ripe papaya pectin
total =1
total ≥2
ACF =1 (norm area)
30
20
10
0
*
*
*

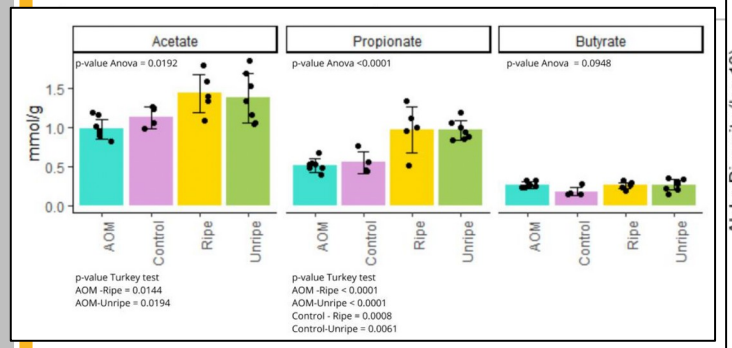



% apoptosis / DAPI
30
20
10
0
*
*
AOM Control
Unripe
Ripe
Negative control

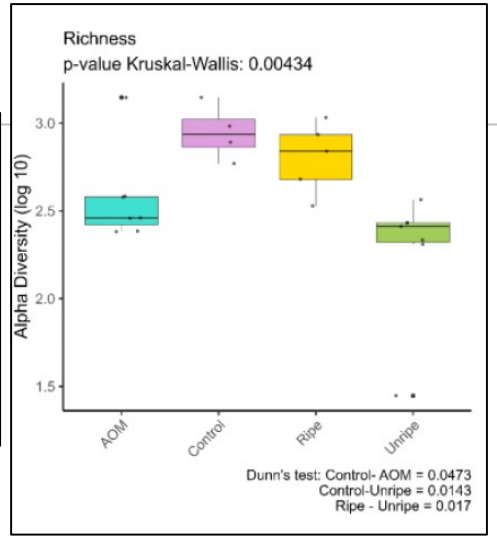
IN VIVO



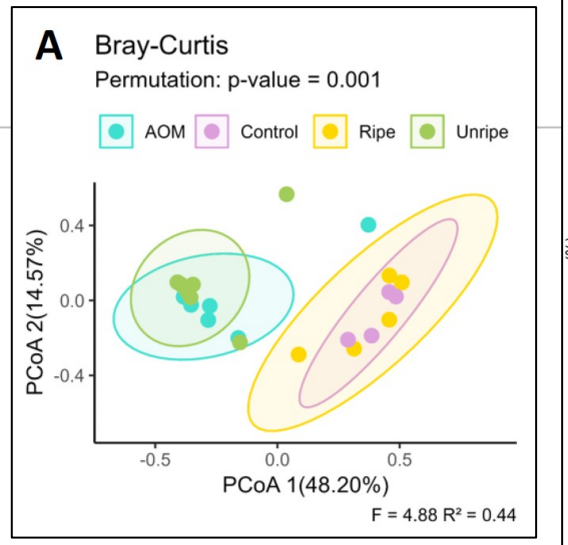
FAPESP WEEK GERMANY



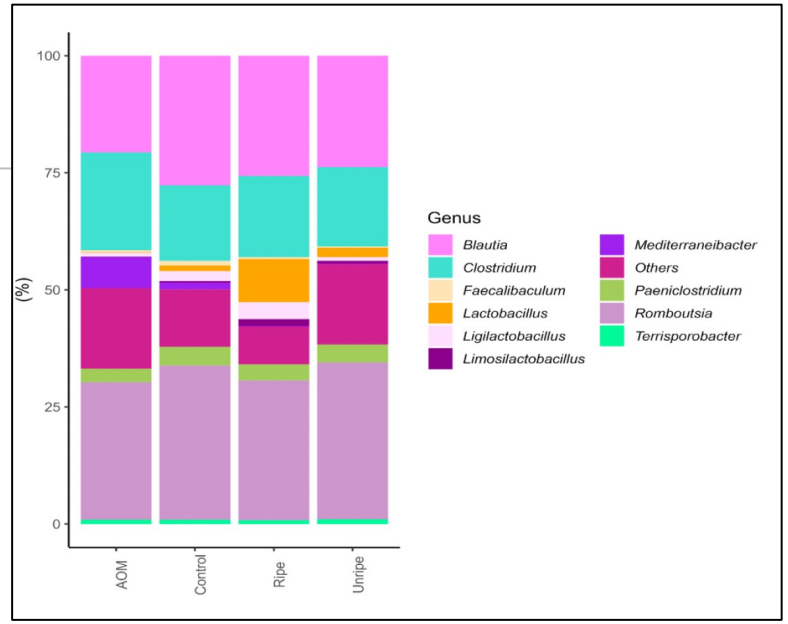
SCFAs

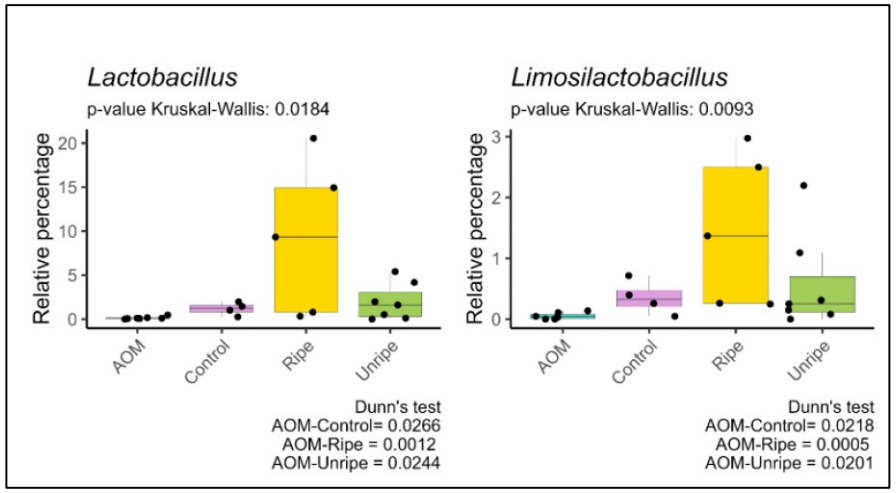


Alpha Diversity

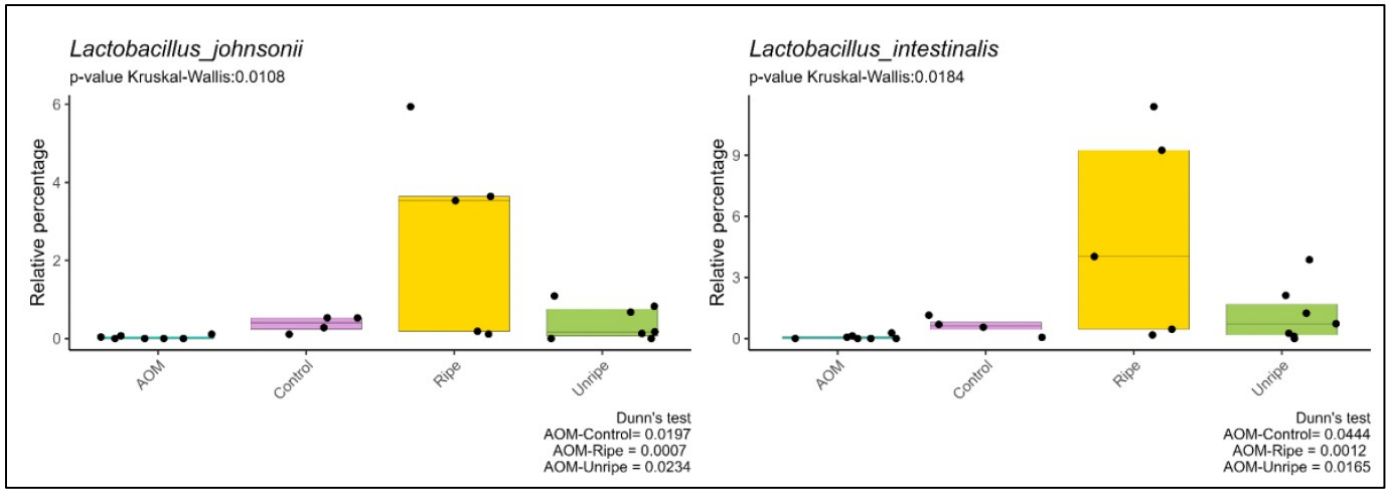


Beta Diversity





Genus



Species

PATENT

***Fabi, J.P.**; Prado, S.B.R.; Shiga, T. "Process for the Extraction and Isolation of Food Fibers Rich in Pectins from Papayas and its Use. Brazil. Patent: Innovation Privilege. Registration number: BR10201807478, Institution of registration: INPI - National Institute of Industrial Property. Deposit: 29/11/2018; Granted: 24/10/2023*

"GREEN" TECHNOLOGY

PASSION FRUIT

PASSION FRUIT FLOUR

- LESS THAN 20% w/w OF SOLUBLE PECTINS

- EXTREMELY HIGH-MOLECULAR WEIGHT PECTINS

Carbohydrate Polymers 335 (2024) 122010

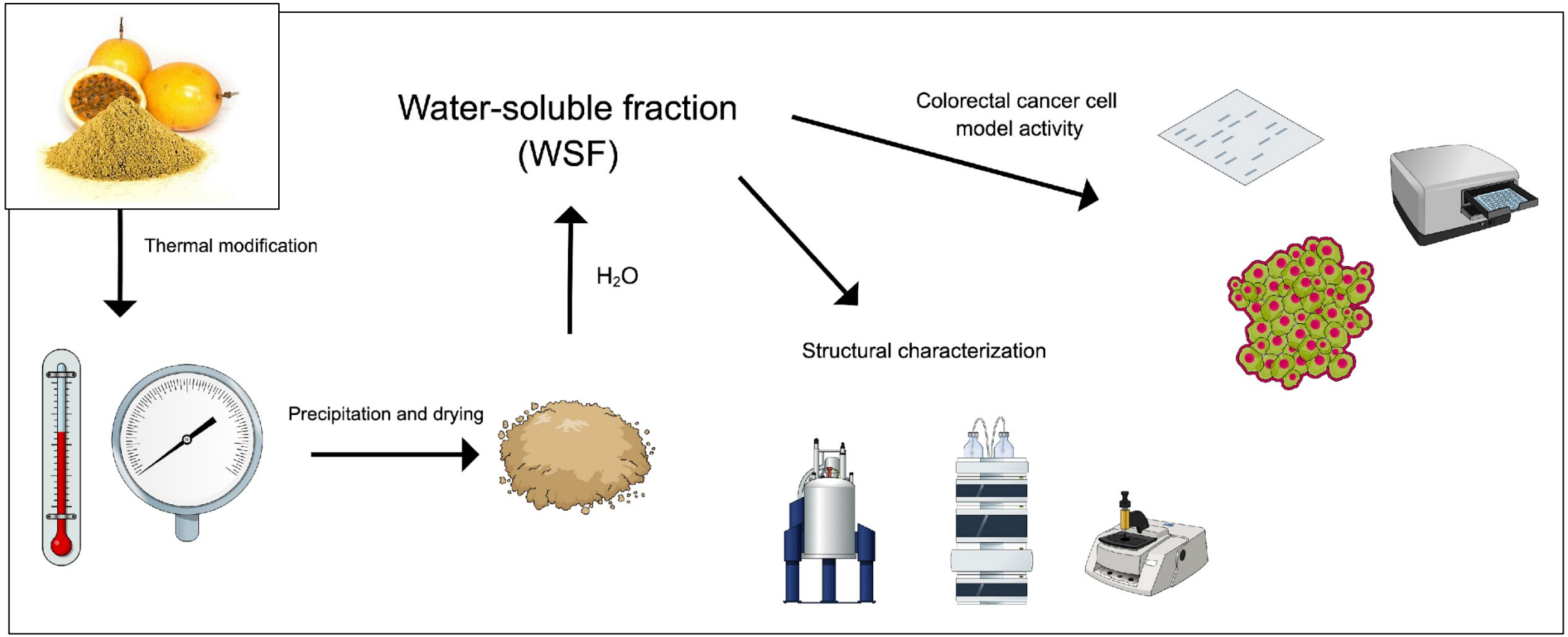
Contents lists available at ScienceDirect

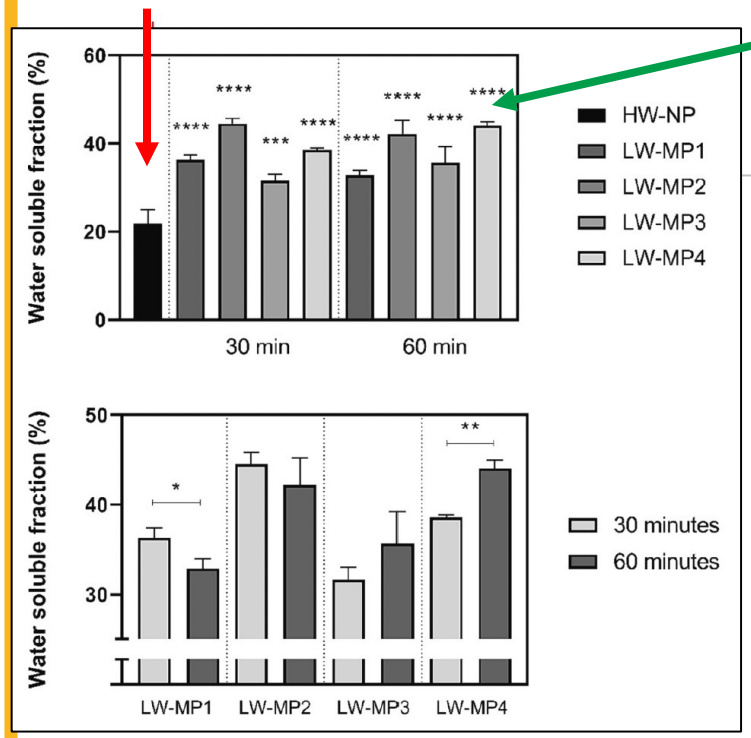
Carbohydrate Polymers

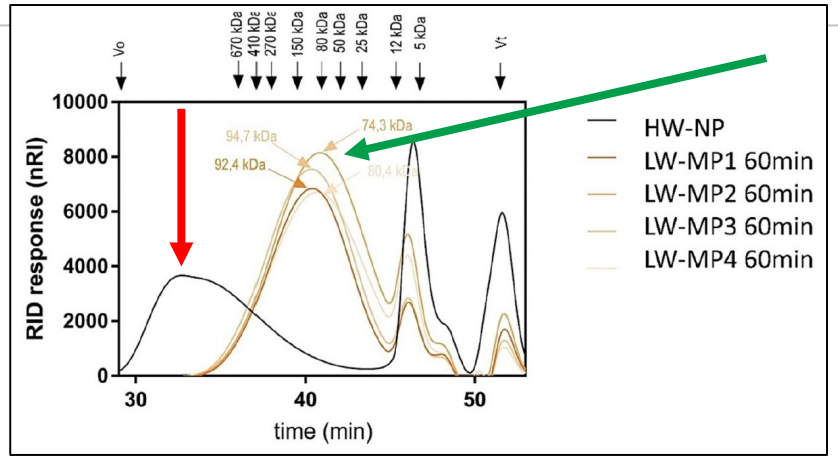
journal homepage: www.elsevier.com/locate/carbpol

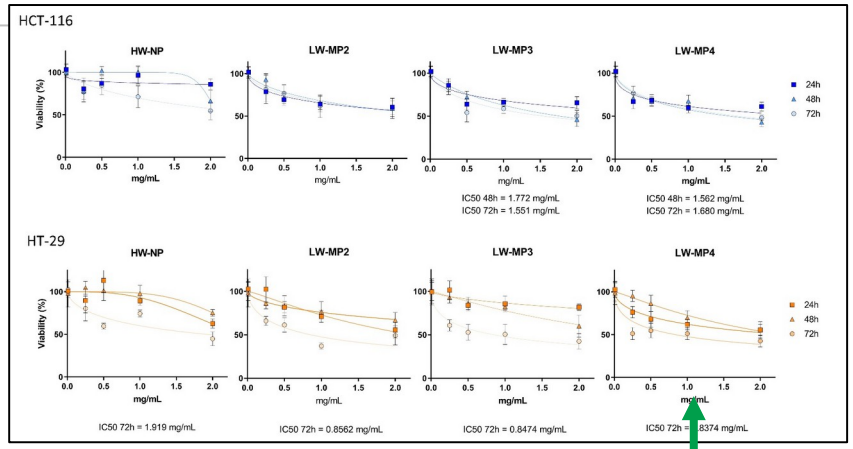
Assessing high-temperature and pressure extraction of bioactive water-soluble polysaccharides from passion fruit mesocarp

Lucas de Freitas Pedrosa [a,b,c], Dimitrios Kouzounis [c], Henk Schols [c], Paul de Vos [b], João Paulo Fabi [a,d,e,*]

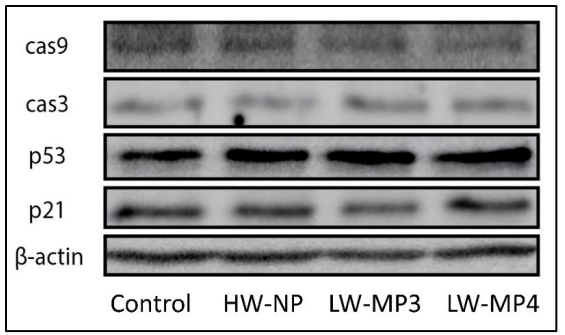


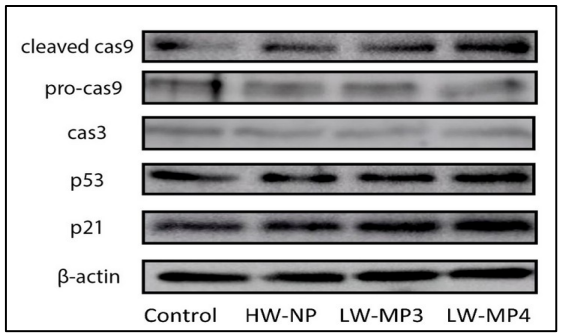






- **MORE THAN 40% w/w OF SOLUBLE PECTINS**
- **MEDIUM-MOLECULAR WEIGHT PECTINS**
- ***IN VITRO* ANTICANCER EFFECTS**

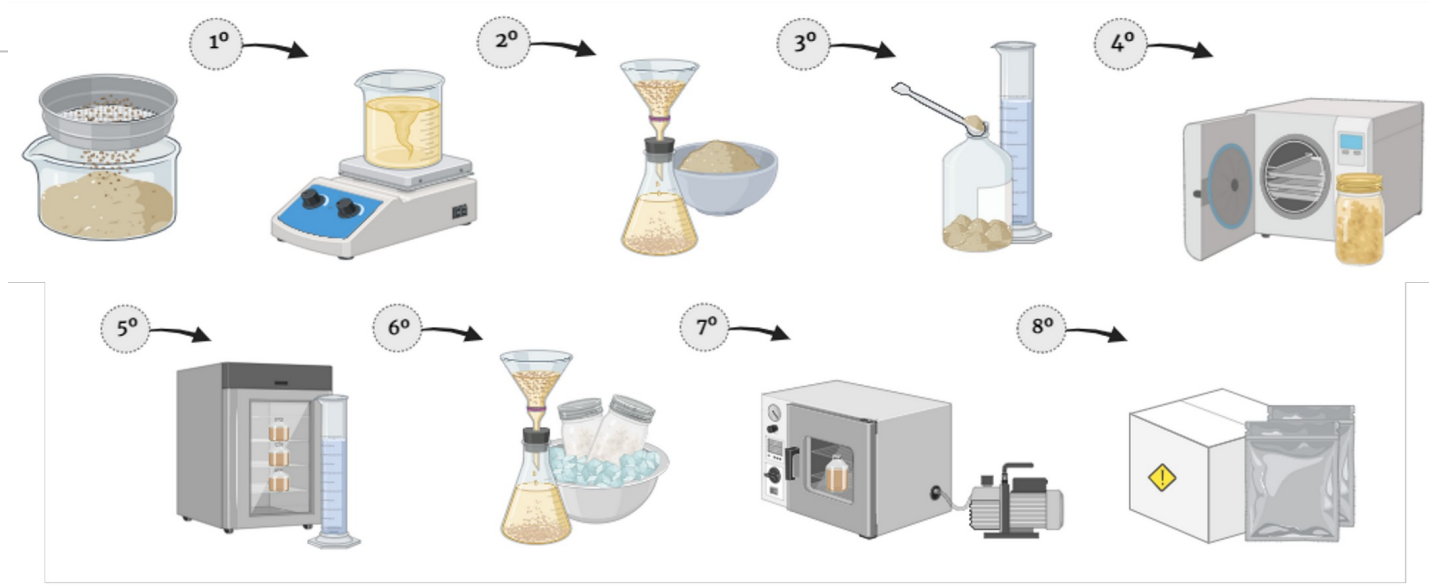




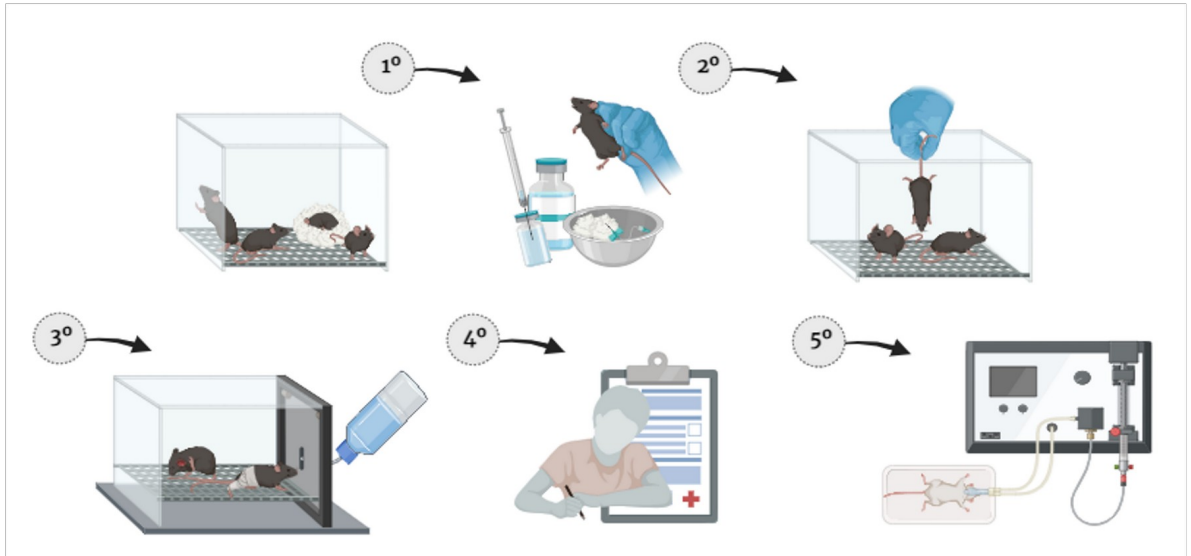
Pedrosa et al., 2024

FAPESP WEEK GERMANY

FIRST STAGE: MODIFICATION OF PECTIN



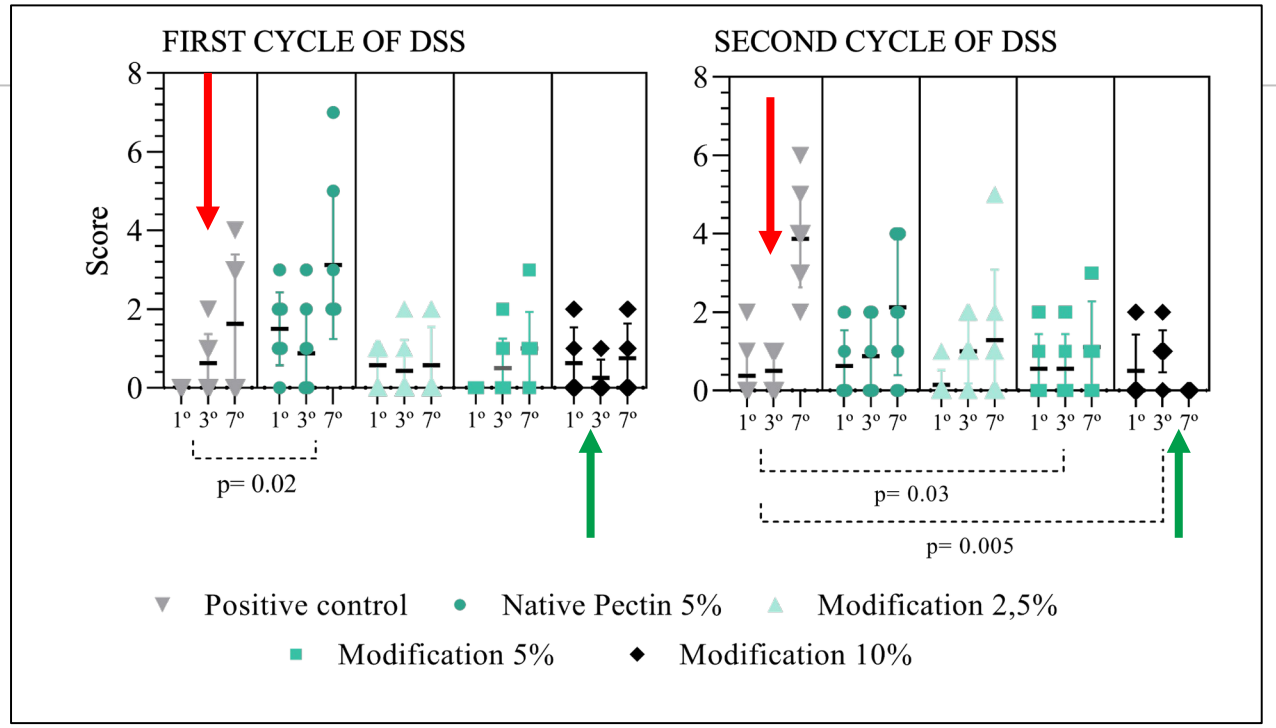
SECOND STAGE: *IN VIVO* EXPERIMENTATION

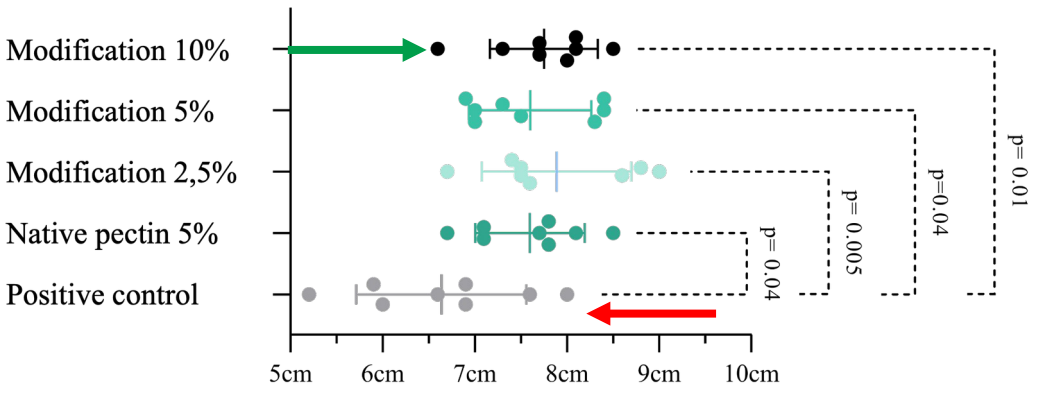


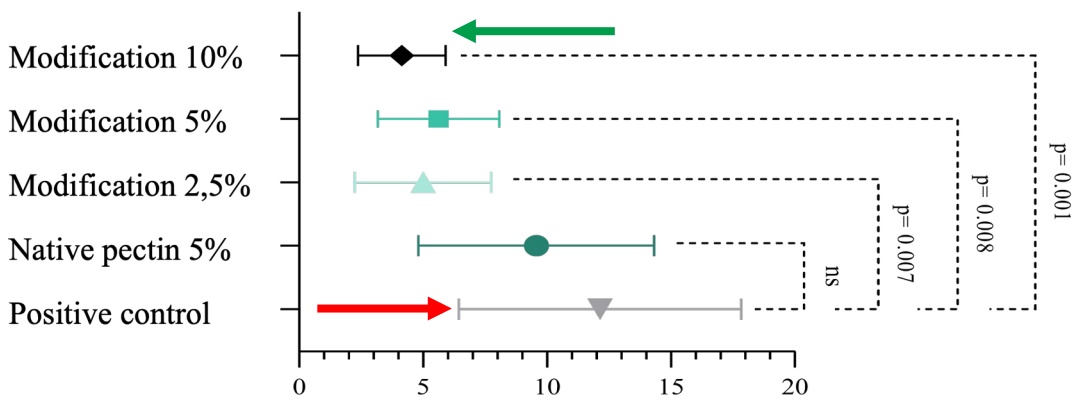
Dextran Sodium Sulfate Azoxymethane

FAPESP WEEK GERMANY

March 25-26th, 2025







PATENT APPLICATION

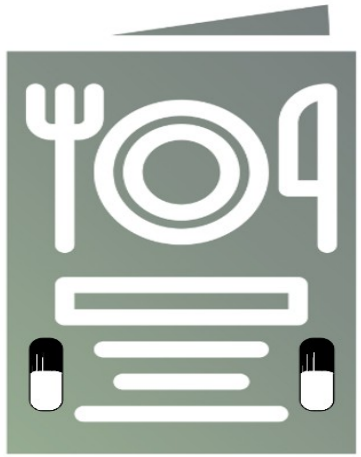
***Fabi, J.P.**; Pedrosa, L.F. "Extraction, purification and production modified pectins from passion fruit flour with beneficial biological effects". Deposit PCT: 28/02/2025.*

"GREEN" TECHNOLOGY

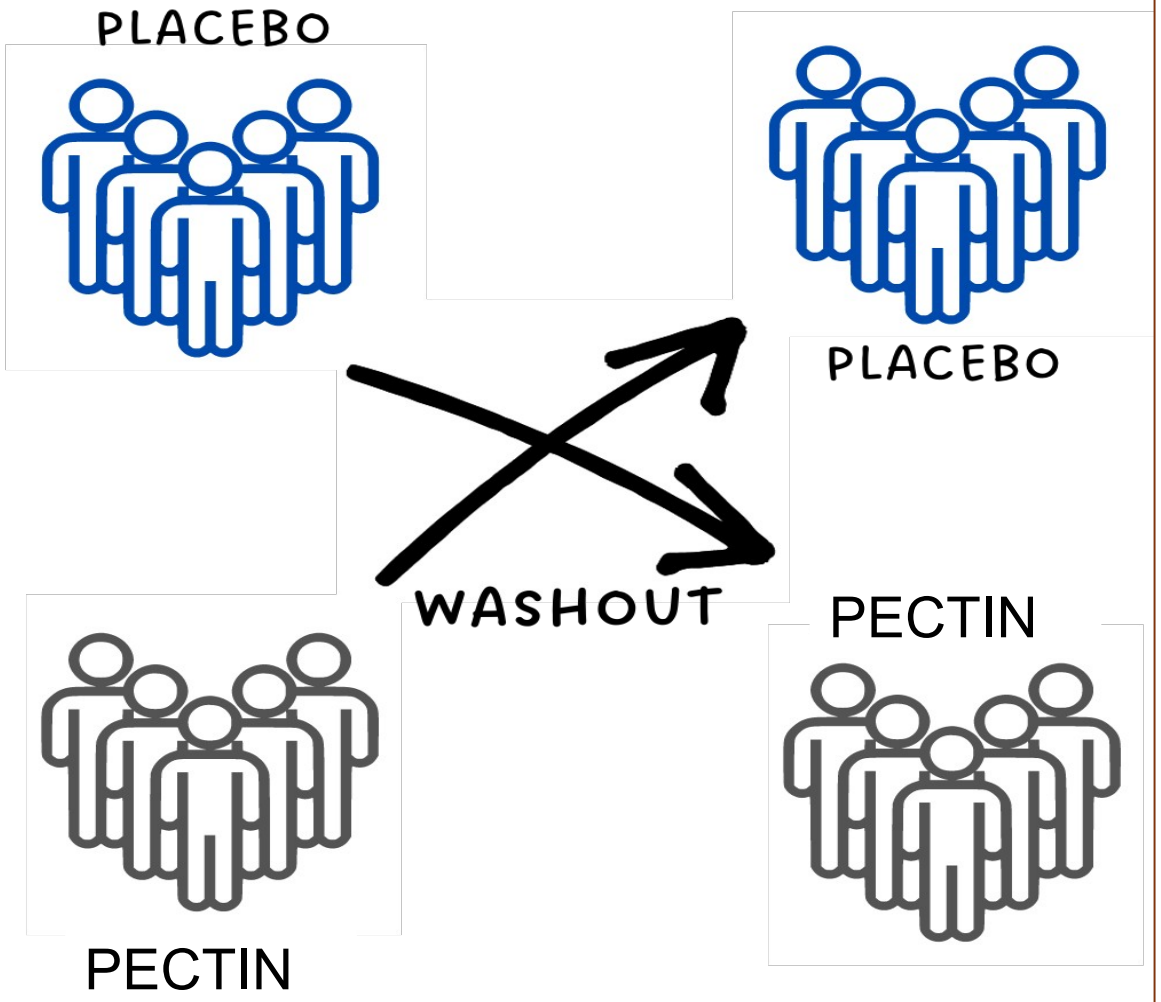
- PREBIOTIC
- IMMUNOMODULATIO N
- ANTICANCER

NEXT STEPS

- Study orientation;
- Exam collection;
- Collection kit delivery.



- Start of the intervention;
- Delivery of the menu.



FAPESP WEEK GERMANY

March 25-26th, 2025

ACKNOWLEDGEMENTS

FAPESP SÃO PAULO RESEARCH FOUNDATION

DFG Deutsche Forschungsgemeinschaft

FAPESP SÃO PAULO RESEARCH FOUNDATION

MIHI QVOQVE TVENDA SANITAS

USP napan

FoRC FOOD RESEARCH CENTER

CCD circulo

CAPES

CNPq

香港中文大學 The Chinese University of Hong Kong

The University of Nottingham

BARBARA ANN KARMANOS CANCER CENTER At the Detroit Medical Center

UCM UNIVERSIDAD CATOLICA DEL MAULE

DUC IN ALTUM UA UNIVERSIDAD AUTONOMA DE CHILE

UNC Universidad Nacional de Córdoba

university of groningen

WAYNE STATE UNIVERSITY

UNIVERSITY of MARYLAND SCHOOL OF MEDICINE

UCR UNIVERSIDAD DE COSTA RICA

Thanks!

Any questions?

You can find me at:

jpfabi@usp.br

@joaopaulofabi

https://sites.google.com/view/biopol-lab