Nutritional Quality of Fresh-cut Products

Dr. Gustavo A. González Aguilar

Fresh-cut Products

The sucess of these products is due to:

- Ready to eat
- Free of chemical preservatives
- Good sensorial and nutritional characteristics

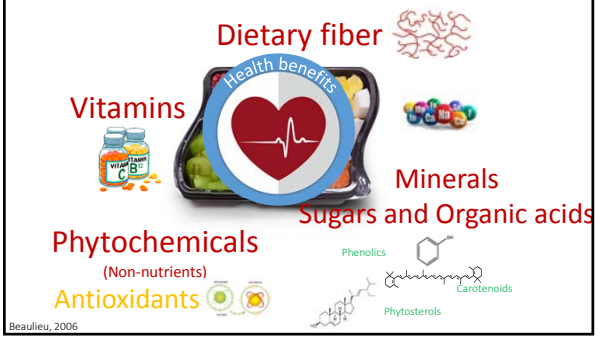
Barrett D. *et al.*, 2010; Beaulieu, 2006

Quality Attributes of Fresh-cut Products

- Color and appearance
- Flavor (taste and aroma)
- Texture
- Nutritional value

"Consumers often buy the first time based on appearance, but repeat purchases are driven by expected quality factors"

Nutritional Value of Fresh-cut Products



Beaulieu, 2006

Table. Some nutrients and phytochemicals in some tropical and subtropical fruits (Yahia, 2011)

Nutrient/Phytochemical	Source	Health benefits
Vitamin C (ascorbic acid)	Citrus fruits, guava, pineapple, mango, papaya	Prevents scurvy, aid wound healing, healthy immune system, cardiovascular disease
Vitamin A (carotenoids)	Orange fleshed fruits such as papaya, mango, pineapple, citrus	Night blindness prevention, chronic fatigue, psoriasis, heart disease, stroke, cataracts
Potassium	Banana plantain, cantaloupe	Hypertention, immune system
Flavan-3-ol: epicatechin, epigallocatechin, catechin, gallocatechin	Mango	Platelet aggregation, cáncer
Flavonones: hesperetin	Citrus fruits	Cancer
Flavonols: quercetin, kaempferol, myricetin, rutin	Papaya	Heart disease, cancer initiation, capillary protectant
Lycopene	Papaya, Brazilian guava	Cancer, heart disease, male infertility
β-Barotene	Mango, cantaloupe, papaya	Cancer

Factors that contribute to the Nutritional Value of Fresh-Cut Products

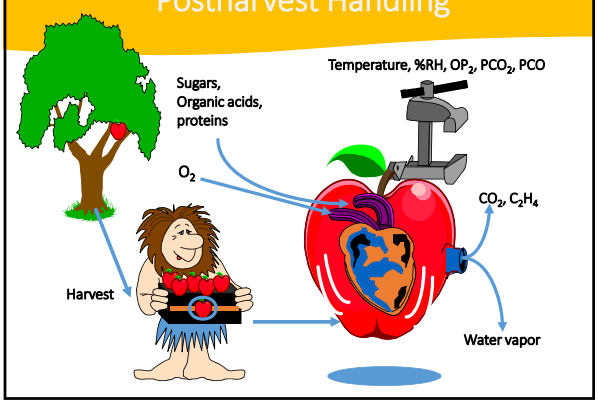
- Genetics growing conditions (light, temperatura, etc.)
- Production practices (fertilization, irrigation, etc)
- Maturity at harvest
- Postharvest handling conditions
- Processing operations

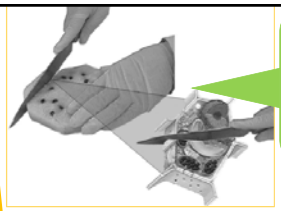
Pre-harvest

Post-harvest

Barrett D. *et al.*, 2010

Postharvest Handling



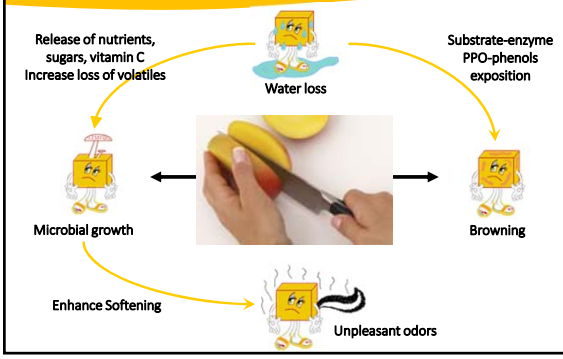


The physical action of cutting and processing produce:
Stress of tissue
Depending on the control of the factors mentioned previously, this may lead to **faster deterioration and loss of nutritional value**.

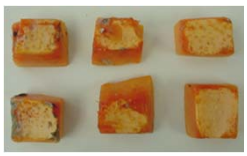
Quality loss → Economic losses

Ayala-Zavala *et al.*, 2009; Gonzalez-Aguilar *et al.*, 2009

Relationship Between the Main Processes of Deterioration of Fresh-cut Products

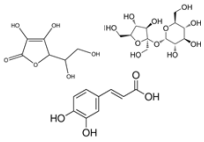


Microbiological Losses



Nutritional losses

- Vitamins
- Sugars
- Organic acids
- Phytochemicals
- Others



Mechanical cutting increased in higher extent the loss of nutrients
Some fruits such as mango is manually processed

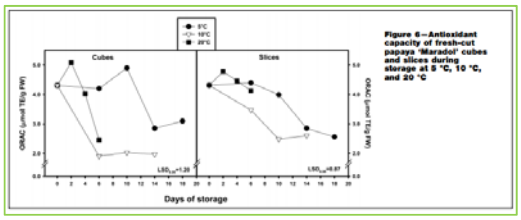
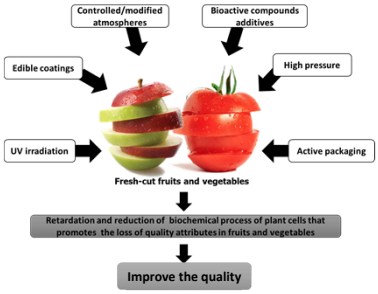


Figure 6—Antioxidant capacity of fresh-cut papaya 'Maradol' cubes and slices during storage at 5 °C, 10 °C, and 20 °C

Effect of temperature on the quality of papaya cubes stored at 5, 10 and 20 °C

Temperature (°C)	Days 2	4	6	10	14
5					
10					
20					

Technologies for Fresh-cut Products



Velderrain-Rodríguez *et al.*, 2015

UV Irradiation

UV irradiation: Type of non-ionizing radiation with wavelenghts from 100 to 400 nm.

- Stimulate beneficial reactions in biochemical systems (hormesis).
- Delay of senescense and fruit ripenning, induction of natural defenses and elicitors against fungi and bacteria.
- Active the plant defense mechanism and microbial DNA damage
- Preserve the quality of fresh-cut products

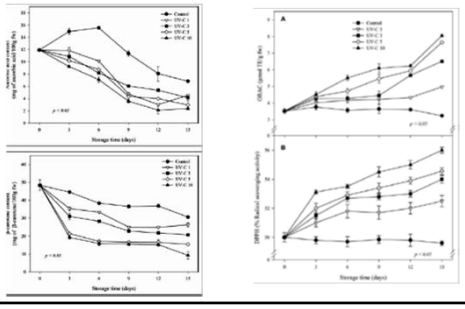
Reduce Vitamin C content, but increased Phenols content and AOC!!

Gonzalez-Aguilar *et al.*, 2010

JFS 9: Sensory and Nutritive Qualities of Food

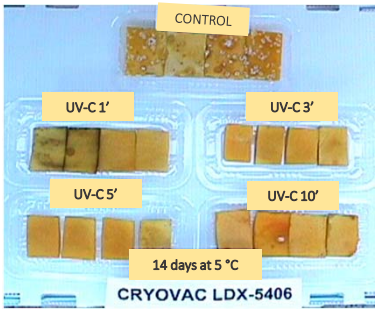
Improving Antioxidant Capacity of Fresh-Cut Mangoes Treated with UV-C

Gustavo A. González-Aguilar, Mónica A. Villegas-Ochoa, M.A. Martínez-Téllez, A.A. Gardea, and J. Fernando Ayala-Zavala



Different exposure times

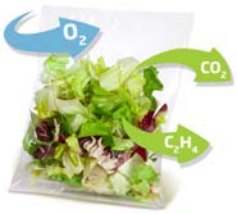
- 0 min (control)
- 1 min
- 3 min
- 5 min
- 10min



Controlled/modified Atmospheres

Active dynamic process that consists in altering the gases surrounding a comodity to produce a composition different from that of air.

- Delay senescence, thus extends storage life and mantain nutritional and sensory quality of fruit at different levels



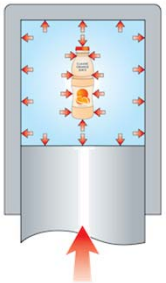
Yahia, 2010; Caleb *et al.*, 2012

High Pressure Processing

This method at refrigeration, ambient or moderate heating temperatura allows inactivation of pathogenic and spoilage microorganisms, and it can play a key role in the extending of the shelf life.

- This technology acts uniformly throughout a food, regardless of size, shape and geometry, and also has minimal effects on the taste, flavor, texture, appearance, and nutritional values of food.

- Used for guacamole processing, release of bioactive compounds, make them more avialable for absorption



Norton and Sun, 2008

Edible Coatings

Thin layer of edible material applied to the surface of food products to extend its shelf life, by reducing moisture and solute migration, gas exchange, respiration and oxidative rates, as well as by reducing or even suppressing physiological disorders.

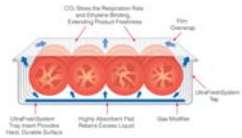
- Protecting aroma, texture and color throughout the storage
- Encapsulating matrices for many bioactive compounds

Norton and Sun, 2008

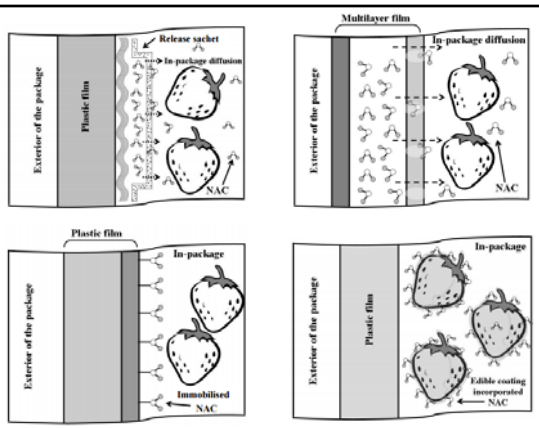
Active Packaging

Intelligent or smart system that involves interactions include oxygen scavengers, carbón dioxide emitter/absorbers, moisture absorbers, ethylene absorbers, etanol emitters, flavor releasing/absorbing systems, time temperature indicators, and antimicrobial films.

- Designed to control deteriorative reactions, and to maintain the nutritional and sensory qualities of different foods.

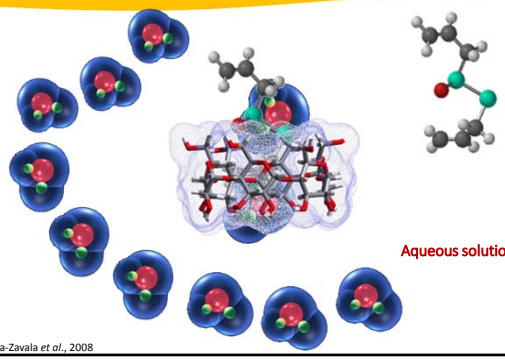


Ayala-Zavala *et al.*, 2008



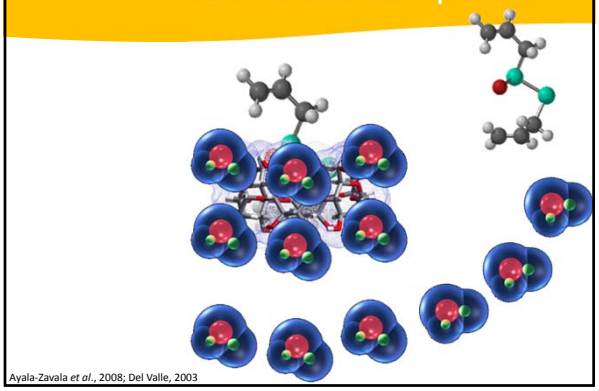
Ayala-Zavala *et al.*, 2008

Complexation of bioactive compounds with β-cyclodextrins



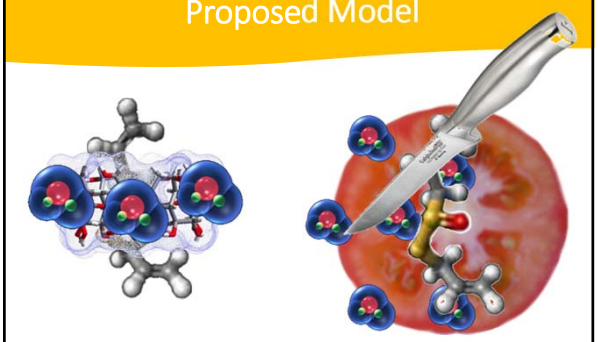
Ayala-Zavala *et al.*, 2008

Release of Bioactive Compound



Ayala-Zavala *et al.*, 2008; Del Valle, 2003

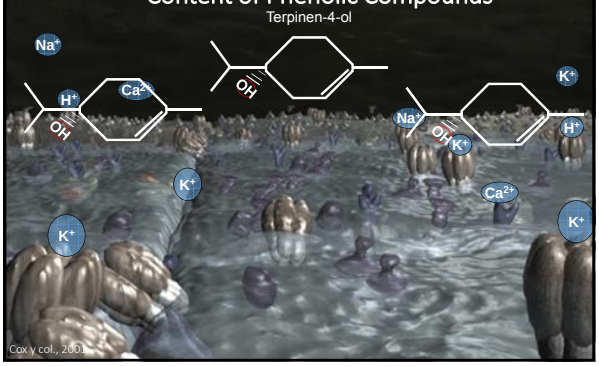
Proposed Model



Microcapsules

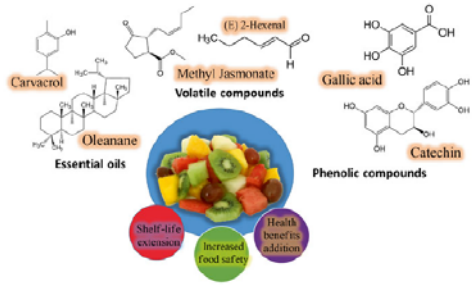
Fresh-cut tomato

Mode of action of complexes with high Content of Phenolic Compounds

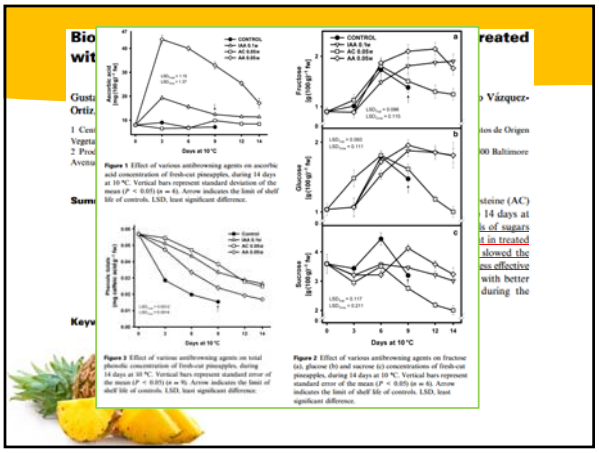


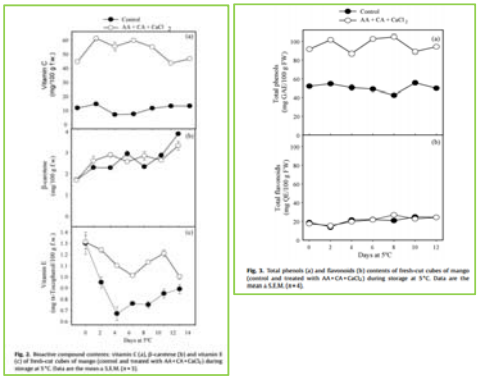
Cox y col., 2001

Bioactive Compounds as Additives

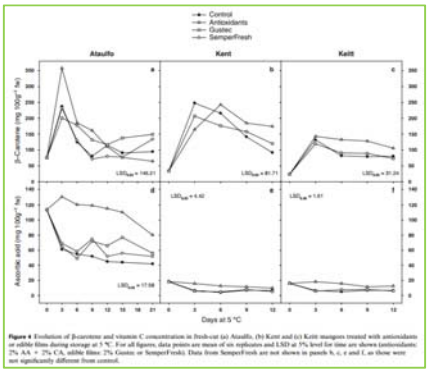


Velderrain-Rodríguez *et al.*, 2015





Increase of nutritional value of mangos



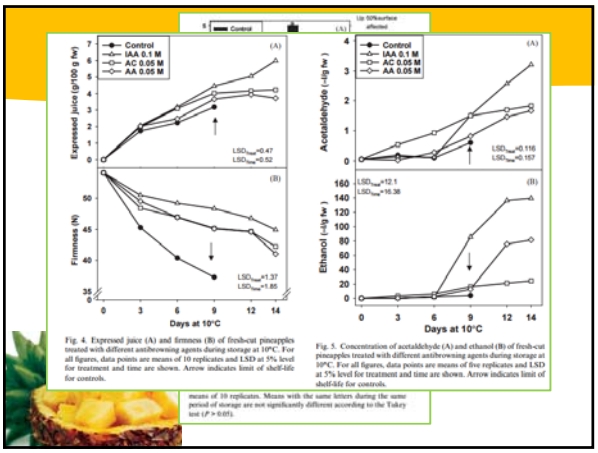


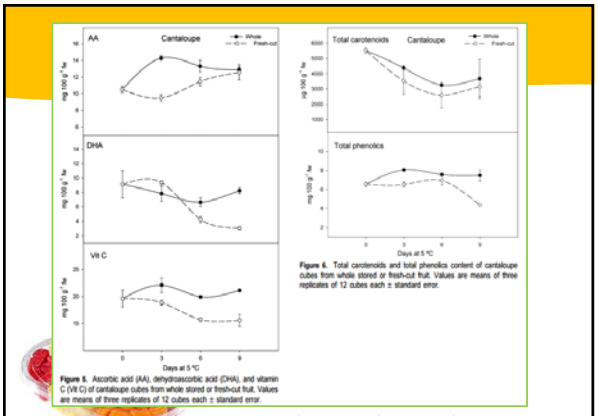
Table 3. Antibacterial activity of the cinnamon leaf oil (CLO) pectin films against *Escherichia coli* O157:H7, *Salmonella* Choleraesuis*, *Staphylococcus aureus* and *Listeria monocytogenes* incubated for 24 h at 37°C

CLO concentration (g/l)	Inhibition zone diameter (mm)			
	E. coli	*S.* Choleraesuis*	*S. aureus*	*L. monocytogenes*
0	ND	ND	ND	ND
7.3	ND	ND	ND	ND
15.7	ND	ND	ND	ND
36.1	16 ± 1	ND	12.3 ± 2	14 ± 1

Salmonella enterica subsp. *enterica* serovar Choleraesuis.
ND, no inhibition was detected.

Table 4. Mesophilic microbial growth (mean value of $\log_{10}$ CFU/g ± standard deviation, $n = 3$) on fresh-cut peach coated with pectin + cinnamon leaf oil (CLO)

Days at 5°C	Treatment				
	Control	Pectin	Pectin + CLO 7.3 g/l	Pectin + CLO 15.7 g/l	Pectin + CLO 36.1 g/l
0	2.39 ± 0.25	<2.39 ± 0	<2.39 ± 0	<2.39 ± 0	<2.39 ± 0
5	4.82 ± 0.85	4.87 ± 0.62	4.00 ± 0.42	<2.39 ± 0	<2.39 ± 0
10	5.34 ± 0.81	5.38 ± 0.84	4.74 ± 0.32	4.54 ± 0.12	4.5 ± 0.98
15	5.30 ± 0.71	5.37 ± 0.86	4.95 ± 0.21	4.32 ± 0.10	3.44 ± 0.56



In general, Fresh-cut fruit visually spoil before any significant loss of nutrient occurs
But the question is. Does these bioactive compounds are avialable?

A simple experiment that demonstrated the bioaccesibility of bioactive compounds of Whole and fresh-cut mangos.

Influence of whole and fresh-cut mango intake on plasma lipids and antioxidant capacity of healthy adults

Maribel Robles-Sánchez, Humberto Astiazarán-García, Olga Martín-Belloso, Shela Gorinstein, Emilio Alvarez-Parrilla, Laura A. de la Rosa, Gloria Yepiz-Plascencia, Gustavo A. González-Aguilar

Fasting plasma antioxidant capacity of healthy human subjects before consumption of mango (FCM or WM) and after 15 and 30 days of dietary intervention.

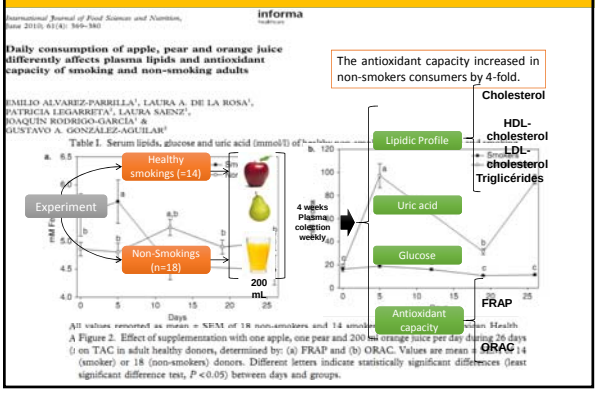
Dietary group	Time	Plasma antioxidant capacity (mmol/TE/L)	
		TEAC	ORAC
WM	0	0.71 ± 0.07a	0.31 ± 0.14a
	15	0.78 ± 0.07b	0.49 ± 0.18b
	30	0.73 ± 0.08a	0.46 ± 0.14c
FCM	0	0.71 ± 0.07a	0.31 ± 0.14a
	15	0.85 ± 0.06b	0.40 ± 0.15b
	30	0.80 ± 0.10b	0.37 ± 0.13b

Values are means ± SD of at least 15 subjects; initial values (time 0) were determined with the values from the 30 participants, values at days 15 and 30 were determined for each dietary group (15 participants). For each dietary intervention group, means in columns with different letters indicate statistically significant differences ($p \leq 0.05$). ORAC, oxygen radical absorbance capacity; TEAC, trolox equivalent antioxidant capacity.

The antioxidant capacity increased in plasma from day 15th and was maintained constant afterwards.

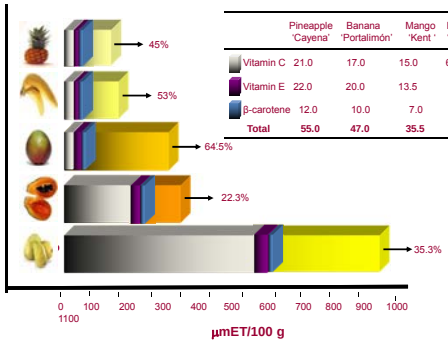
It appears that bioactive compounds are avialable in both tissues

What about if we mix whole fruit and fruit juice? after ingestion the bioacive compounds are avialable???



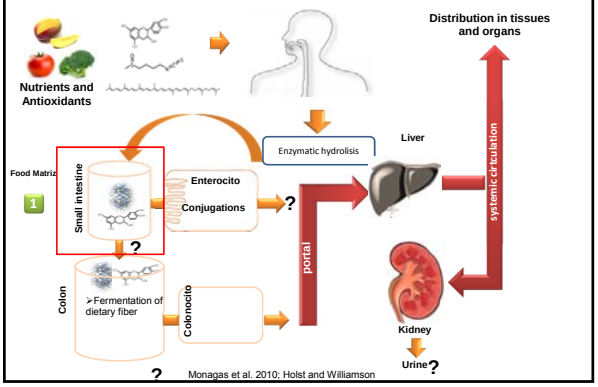
The antioxidant capacity increased in non-smokers consumers by 4-fold.

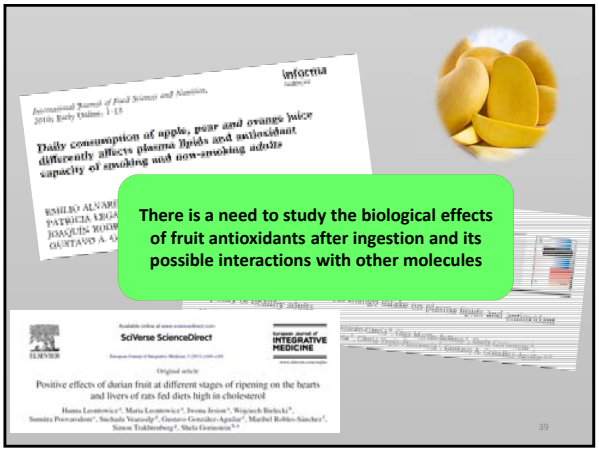
Another important aspect that we have to considered, is the individual contribution of Bioactive compounds to the antioxidant capacity in tropical fruits



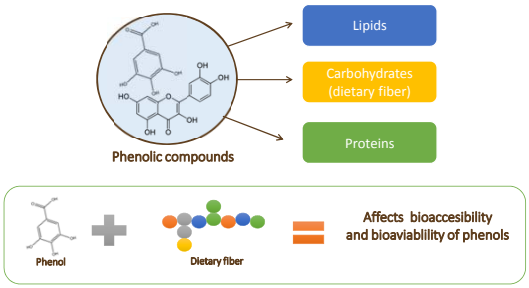
	Pineapple 'Cayena'	Banana 'Portalimón'	Mango 'Kent '	Papaya 'Maradol'	Mango 'Ataulfo'
Vitamin C	21.0	17.0	15.0	63.0	58.0
Vitamin E	22.0	20.0	13.5	9.5	4.5
β-carotene	12.0	10.0	7.0	5.0	2.5
Total	**55.0**	**47.0**	**35.5**	**77.5**	**64.7**

The study of bioaccesibility and bioavaibility of nutrients of fresh-cut after consumption and the pharmokinetics is of great interest



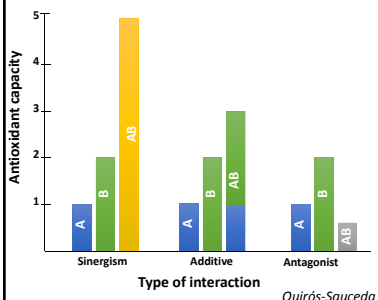


Interaction of phenolic compounds with other molecules



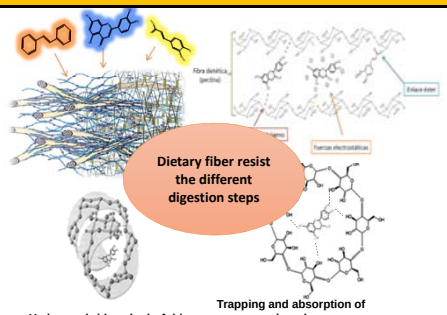
(Manach *et al.* 2005; Saura-Calixto 2011, Padayachee *et al.* 2012)

Interactions between antioxidants : ¿good or bad?



Quirós-Sauceda A.E., Salmerón-Ruiz M.L., Palafox-Carlos H., González-Aguilar G.A. ***Alimentaria (2013).***

Interactions of phenols with dietary fiber



Eastwood y Morris, 1992

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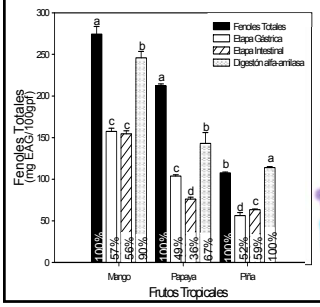
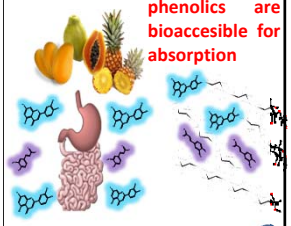
Bioaccesibility of nutrients in tropical fruits





50% of total phenolics are bioaccesible for absorption

Velderrain-Rodríguez, 2013

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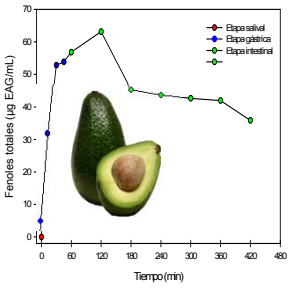
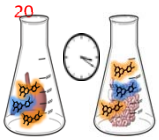
Release kinetics of phenolic compounds from avocado pulp



% release

- **Salival step**: 2.5
- **Gastric:** 17.5-30
- **Intestinal:** 32.5-20



Datos no publicados

Guacamole has 3-fold higher release

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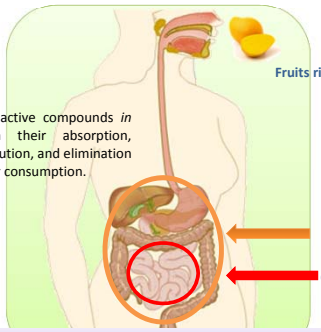
Health benefits of fresh-cut fruits

Positive health bioactive compounds *in vivo* depend on their absorption, metabolism, distribution, and elimination from the body after consumption.



Fruits rich in antioxidants

Gastrointestinal tract
Bioaccesibilidlity (release)
Bioaviability (absorption)
Colon
Catabolism microbiota

Health

Factors affect these processes:

- Food Microestructure
- Interactions with other matrix compounds (dietary fiber)
- Chemical estructure and molecular weight

Fresh-cut Fruit antioxidants

- Antioxidant potential
- Pharmacokinetics
- Nutrigenomics

(WHO, 2003; González-Aguilar *et al.* 2008; Palafox-Carlos *et al.* 2012)

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