



Mangos: Socializing a Globally Popular Fruit with Americans

Unpacking the Science and Exploring New Research Opportunities

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Disclosures

- Employment
 - Illinois Institute of Technology
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 - NIH – Nutrition for Precision Health
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 - U.S. Food and Drug Administration
 - California Strawberry Commission
 - Hass Avocado Board
 - National Mango Board
 - California Fig Advisory Board
 - University of Indiana / Foundation
 - PepsiCo, Ingredion
- Advisory Boards
 - Nutrient Institute
 - McCormick Science Institute

Outline

- Practical Implications and the Fruit Gap
- Mango Basics
- Unique Attributes of Mangos
- Health Benefits: Published Research
- Key Takeaways

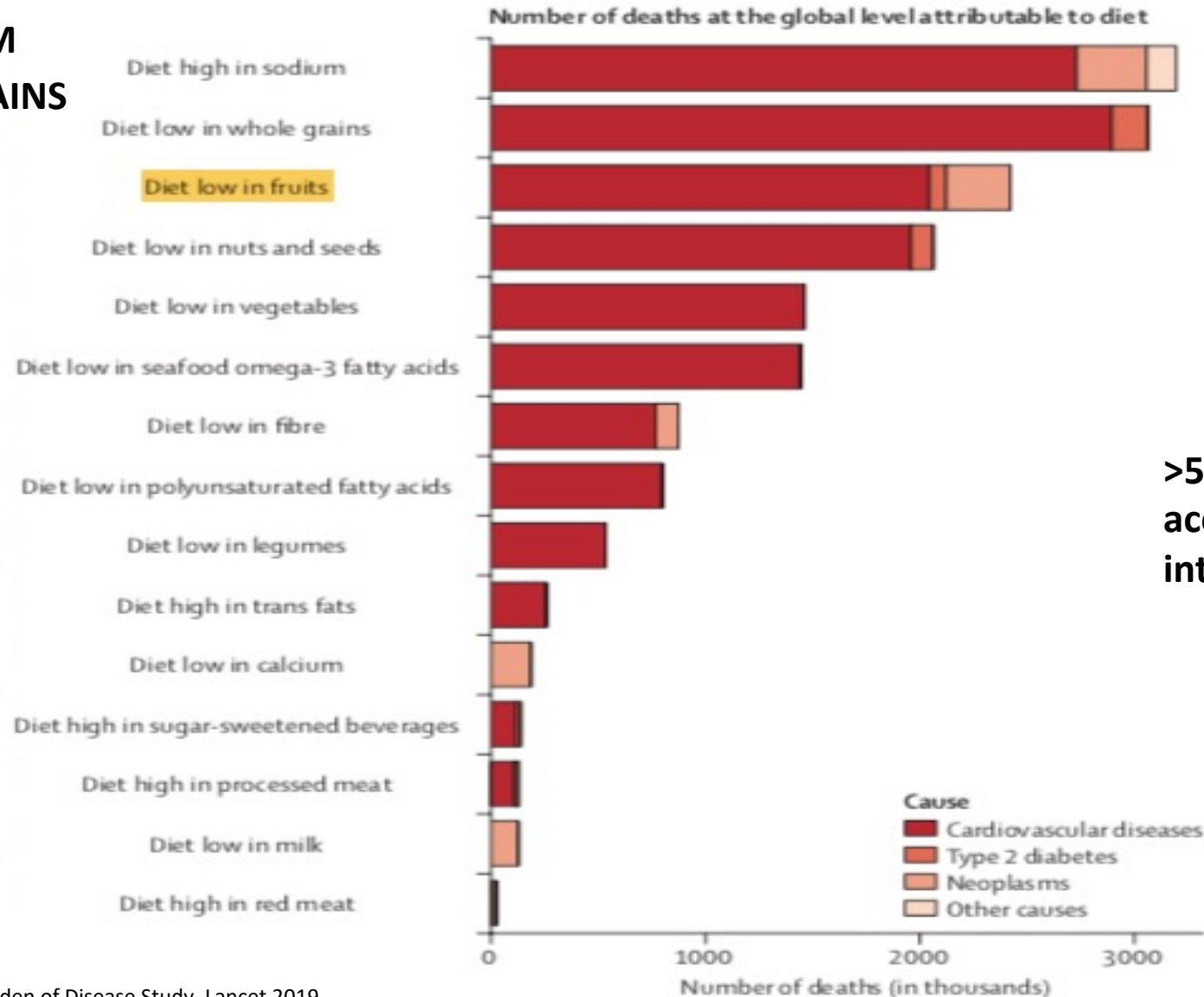


Implications – Why is this Research so Important?

- Global Burden of Disease (GBD) study tells us a diet low in fruit is among the **top 3 dietary risk factors for CVD & Diabetes**
- Need evidence for **specific foods to eat and why**?
 - AACE/ACE Medical guidelines for Diabetes and Pre-diabetes
- **Need evidence** for devising **fruit recommendations: amount and variety** to reduce disease risk and promote health
 - Dietary Guidelines for Americans
- **People want to know – what foods/fruits and how much to eat to optimize health**

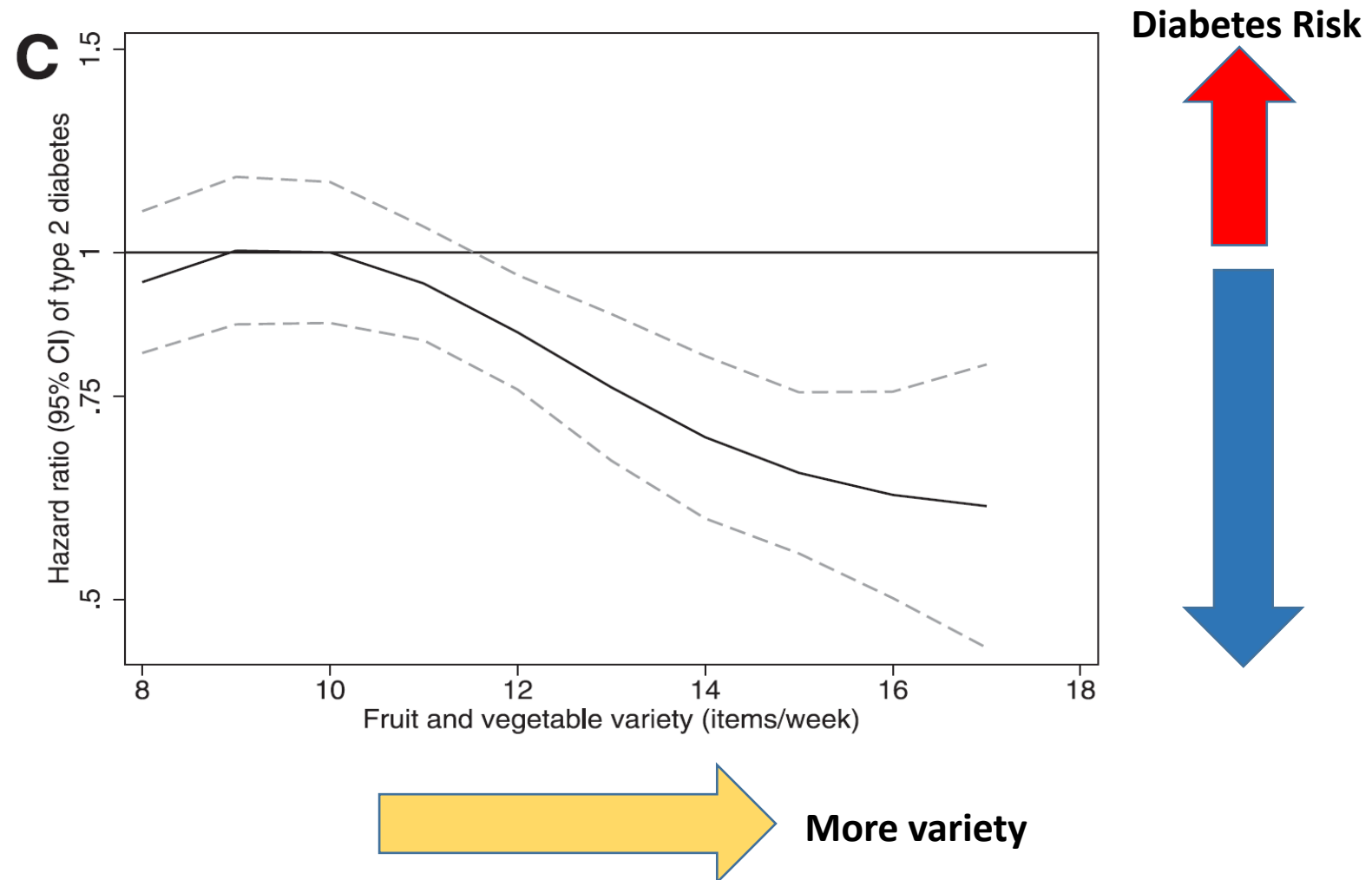
Number of Deaths Due to Individual Dietary Risks

1. Diet HIGH in SODIUM
2. Diet LOW in WH GRAINS
3. Diet LOW in FRUITS

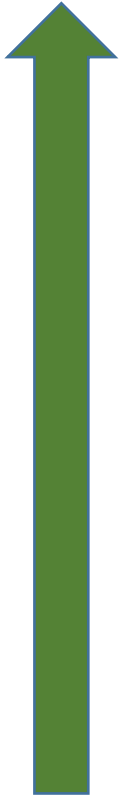


>50% of deaths and 66% DALYs accounted for by non-optimal intake of top dietary factors

Importance of Eating a Variety of Fruit



Addressing the Fruit Gap



**Increase AMOUNT of
total fruit
consumed**



**Increase DIVERSITY of
nutrients and “bioactives” phytochemicals
in the diet**

Mango Facts

70 calories for $\frac{3}{4}$ cup (124 g)

What you may already know

- Great tasting
- Available year-round
- Versatile & Convenient
- Low-calorie / Low-energy density
- Contain a variety of nutrients



Nutrient Content Claims:

- Excellent source of vitamin C, 50% DV
- Good source of folate, 15% DV
- Good source of copper, 15% DV

Mangos and Vitamin C



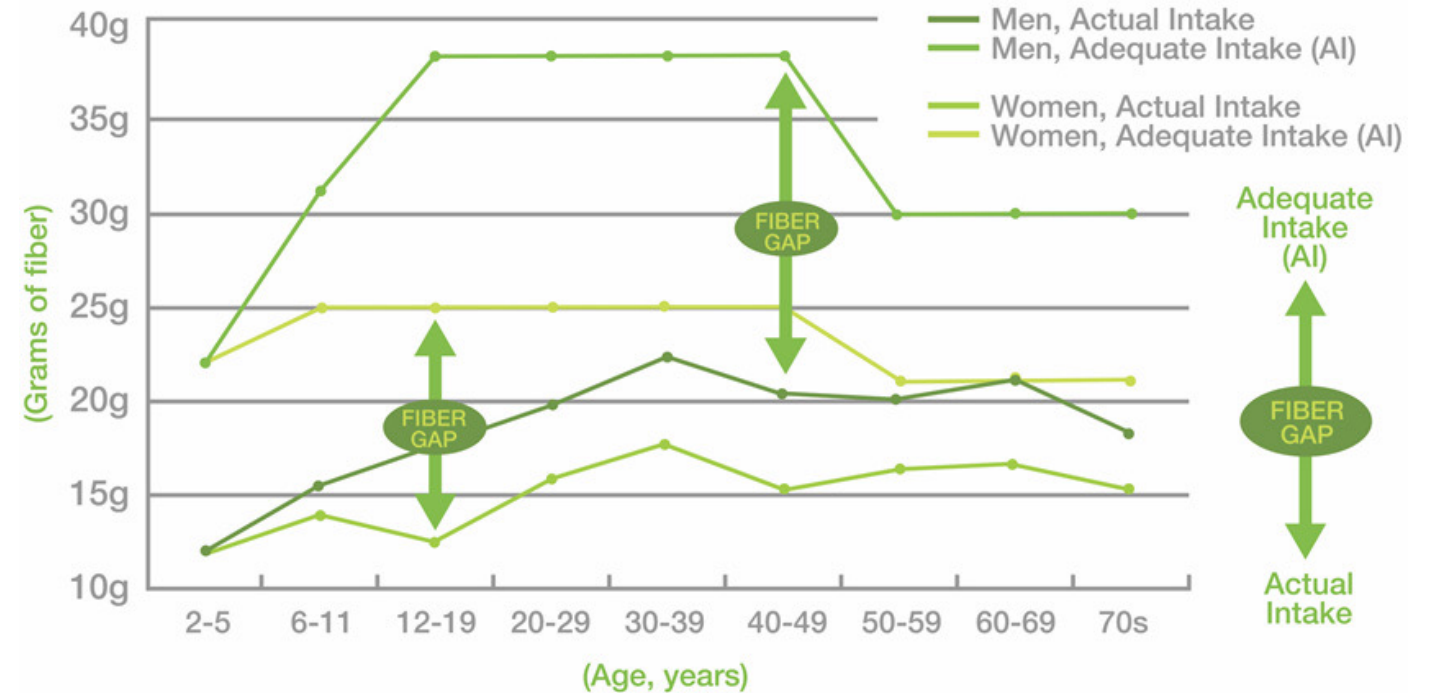
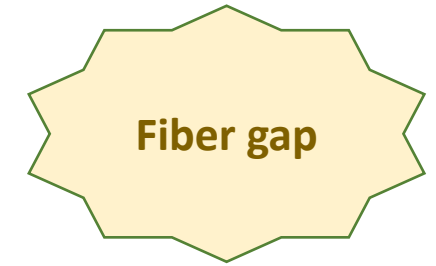
**45 mg / NLEA serving
50% DV → Excellent source**

Mangos and Folate



**53 ug / NLEA serving
15% DV → Good source**

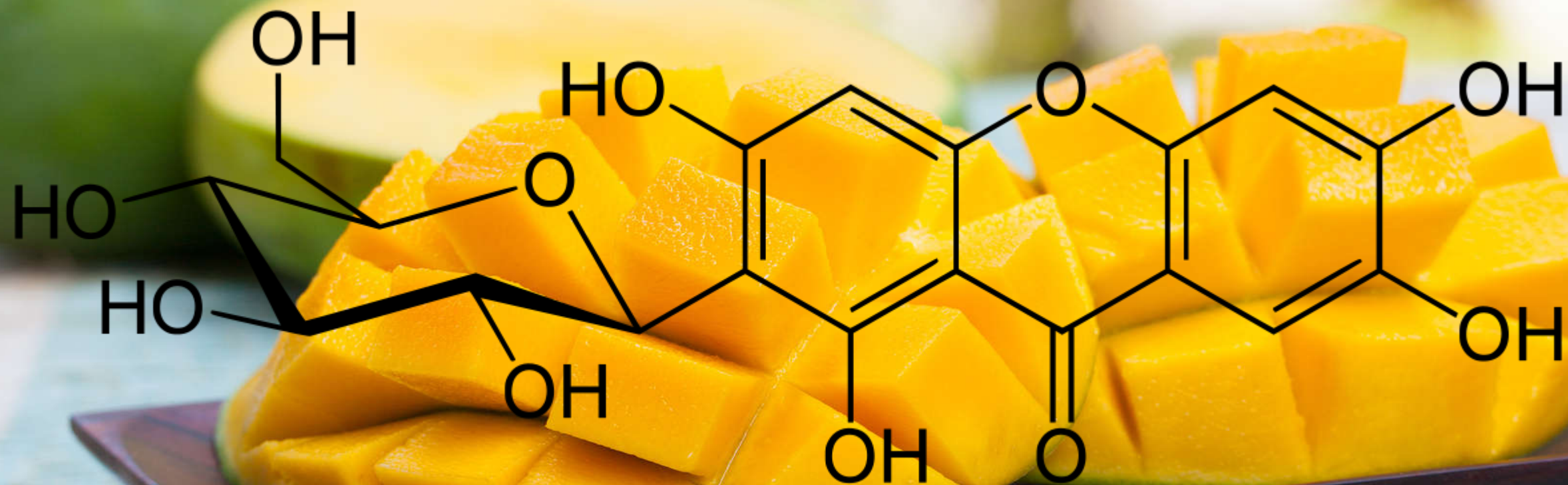
Mangos and Fiber



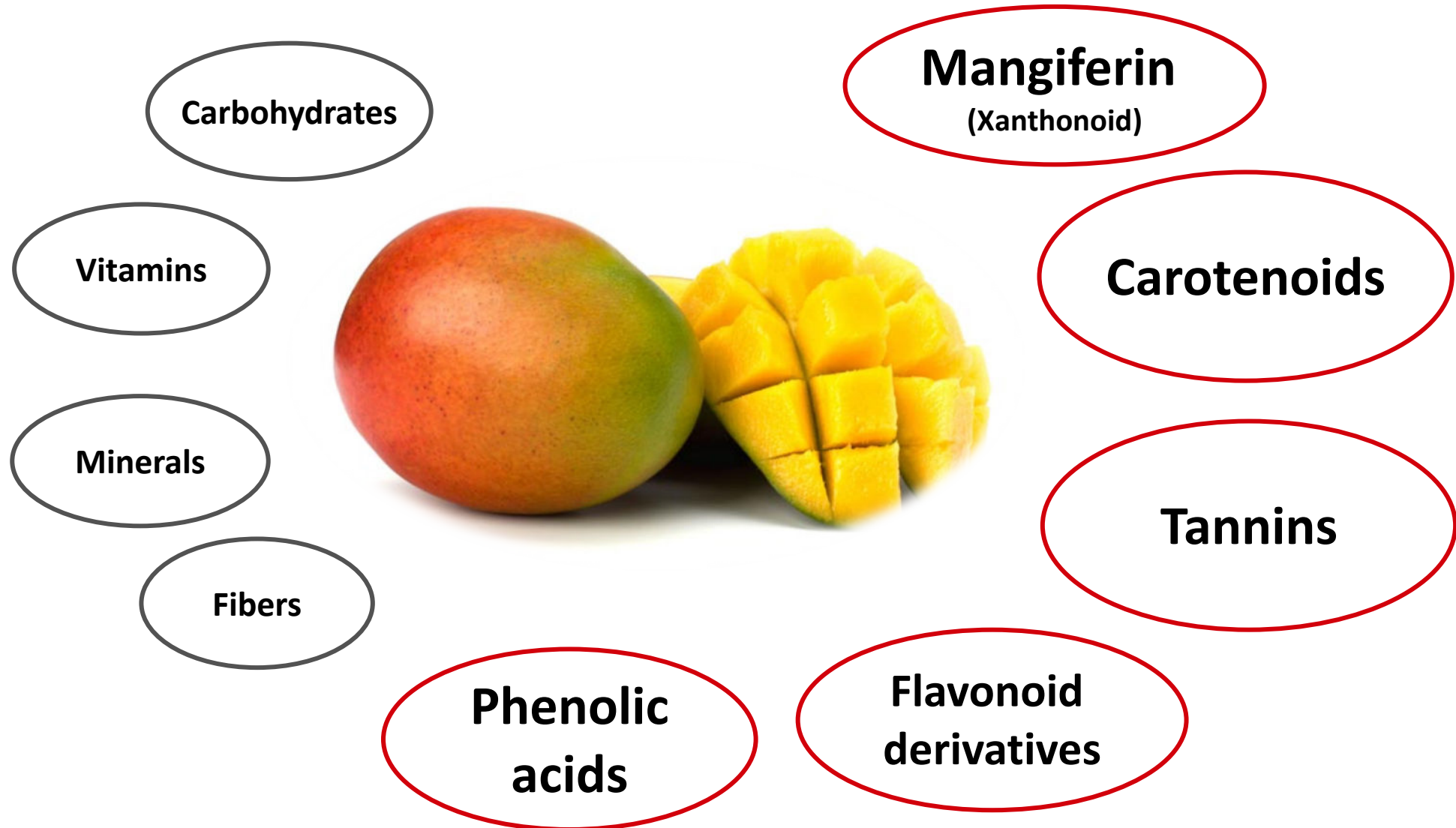
Source: What We Eat in America, NHANES 2011-2012

Carbohydrate: Sugar Stats

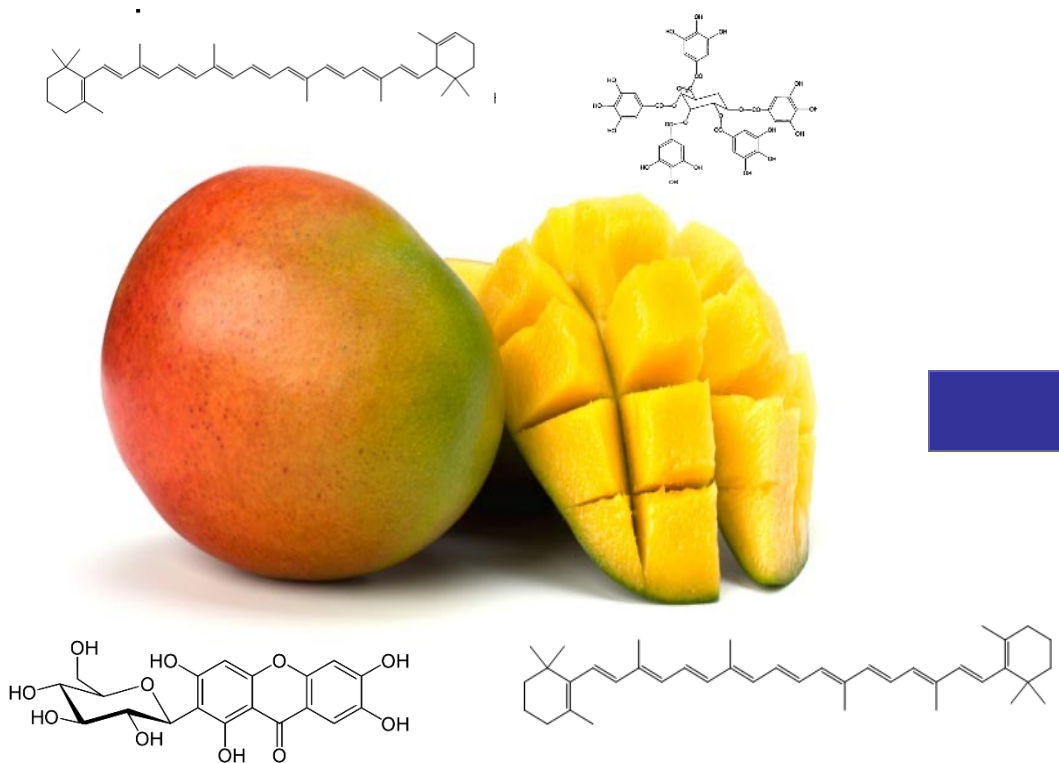
Fruit	Standard Reference 100 (g)					
	Calories	SUGAR (g)	Sucrose (g)	Glucose (g)	Fructose (g)	G:F Ratio
Mangos	60	13.7	7	2.0	4.7	0.43
Grapes	69	15.5	0.2	7.2	8.2	0.88
Apple	52	10.4	2.1	1.9	6.1	0.31
Banana	89	12.2	2.4	5.0	4.9	1.02
Orange	50	8.6	4.3	2.0	2.3	0.87
Strawberry	32	4.9	0.5	2.0	2.4	0.83



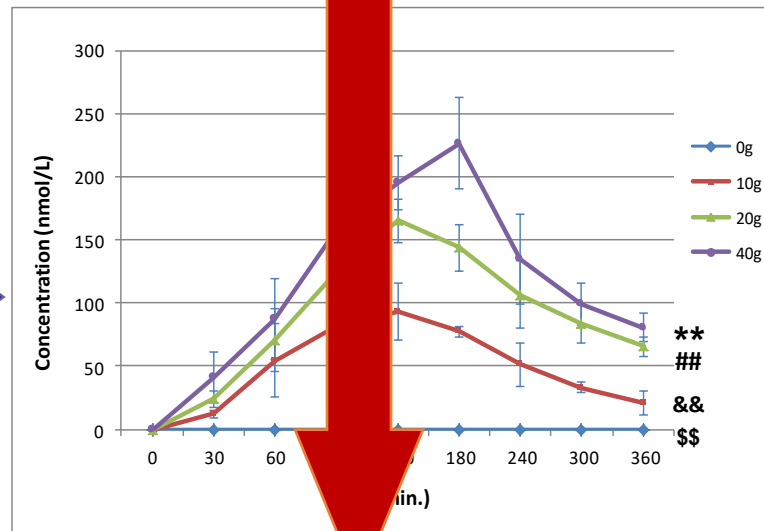
Phytochemical “Bioactives”



Fruit Polyphenols, Metabolites, Health



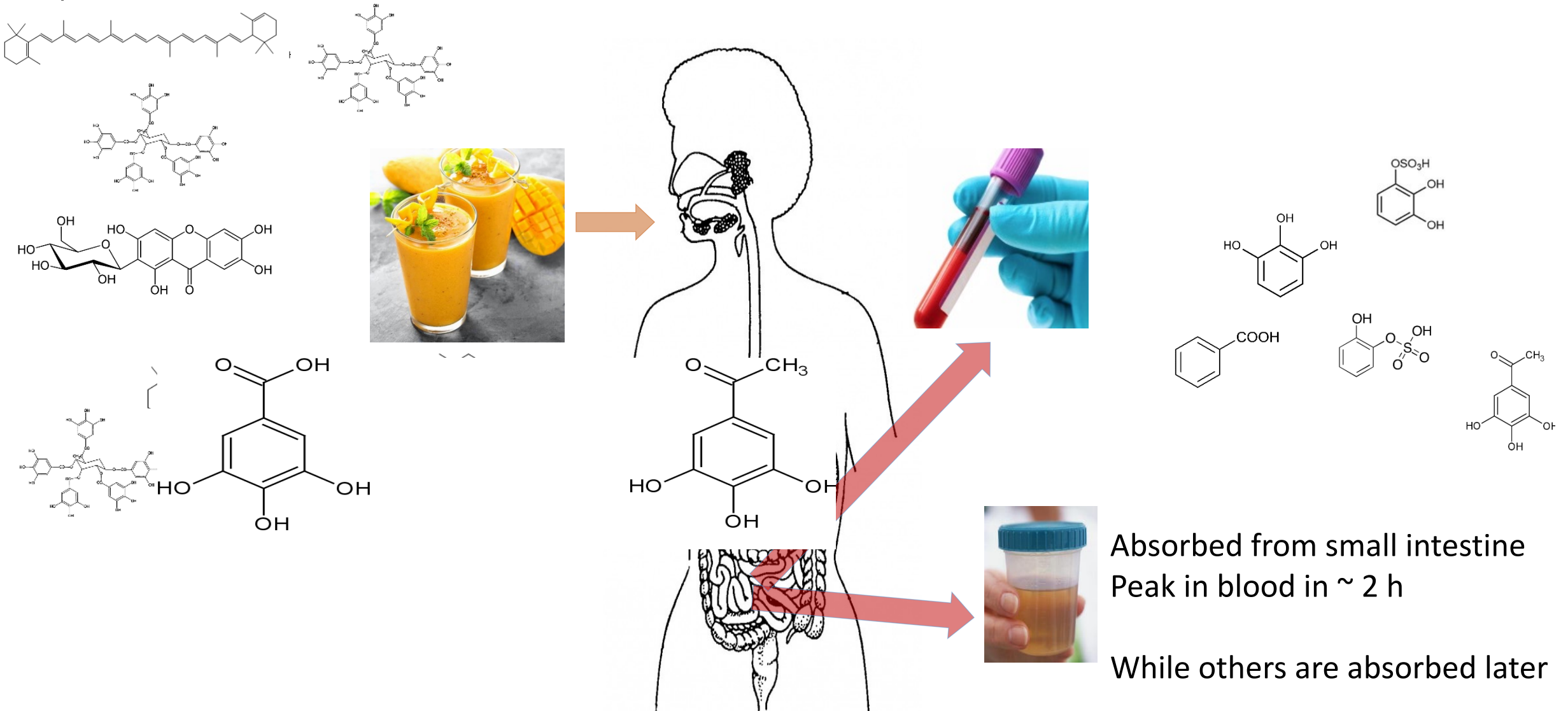
Blood



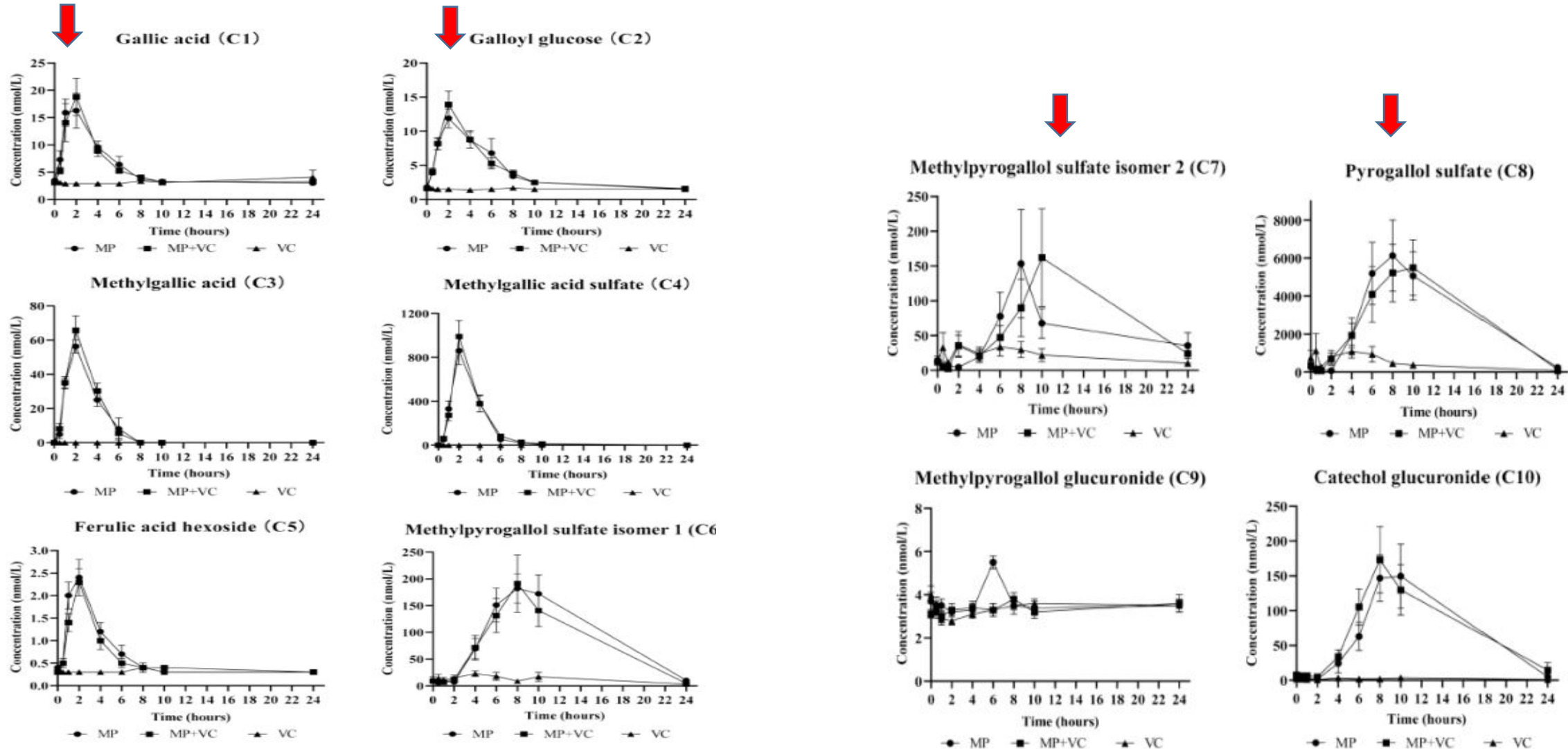
Bio- Health
ENDPOINT
??



Are These “Bioactives” Bioavailable?

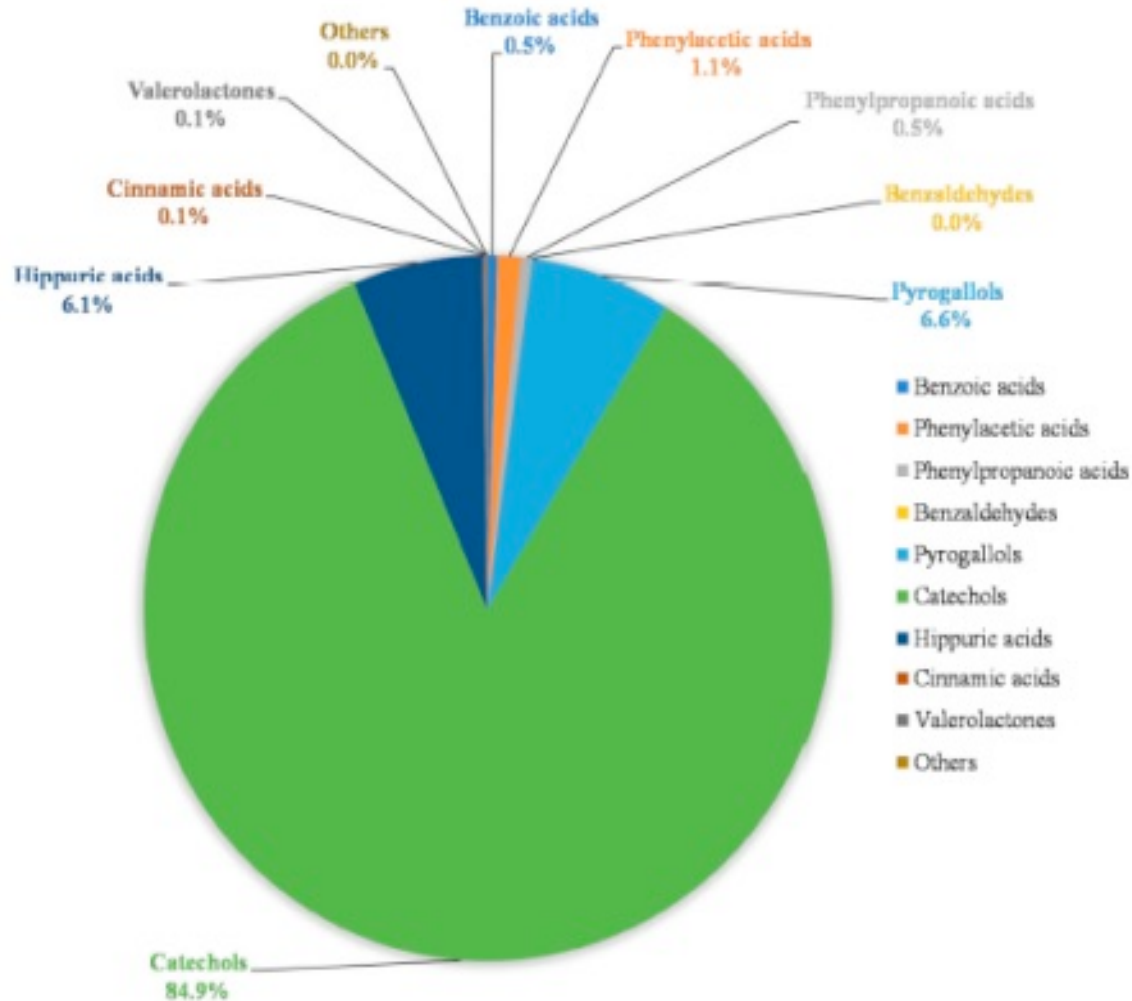


YES – Mango Phyto-Bioactives are Bioavailable

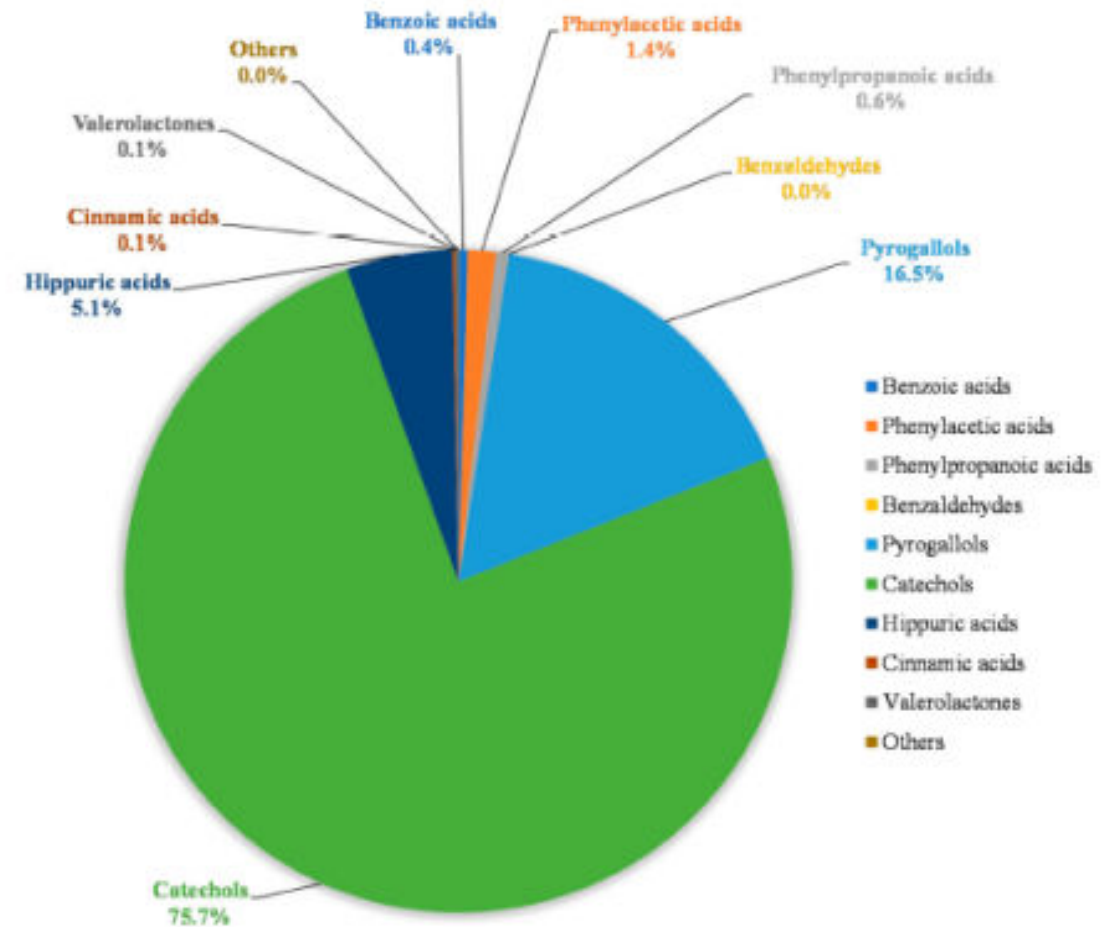


Eating Mangos Daily for 2 Weeks Increases Select Metabolites Measured in Urine

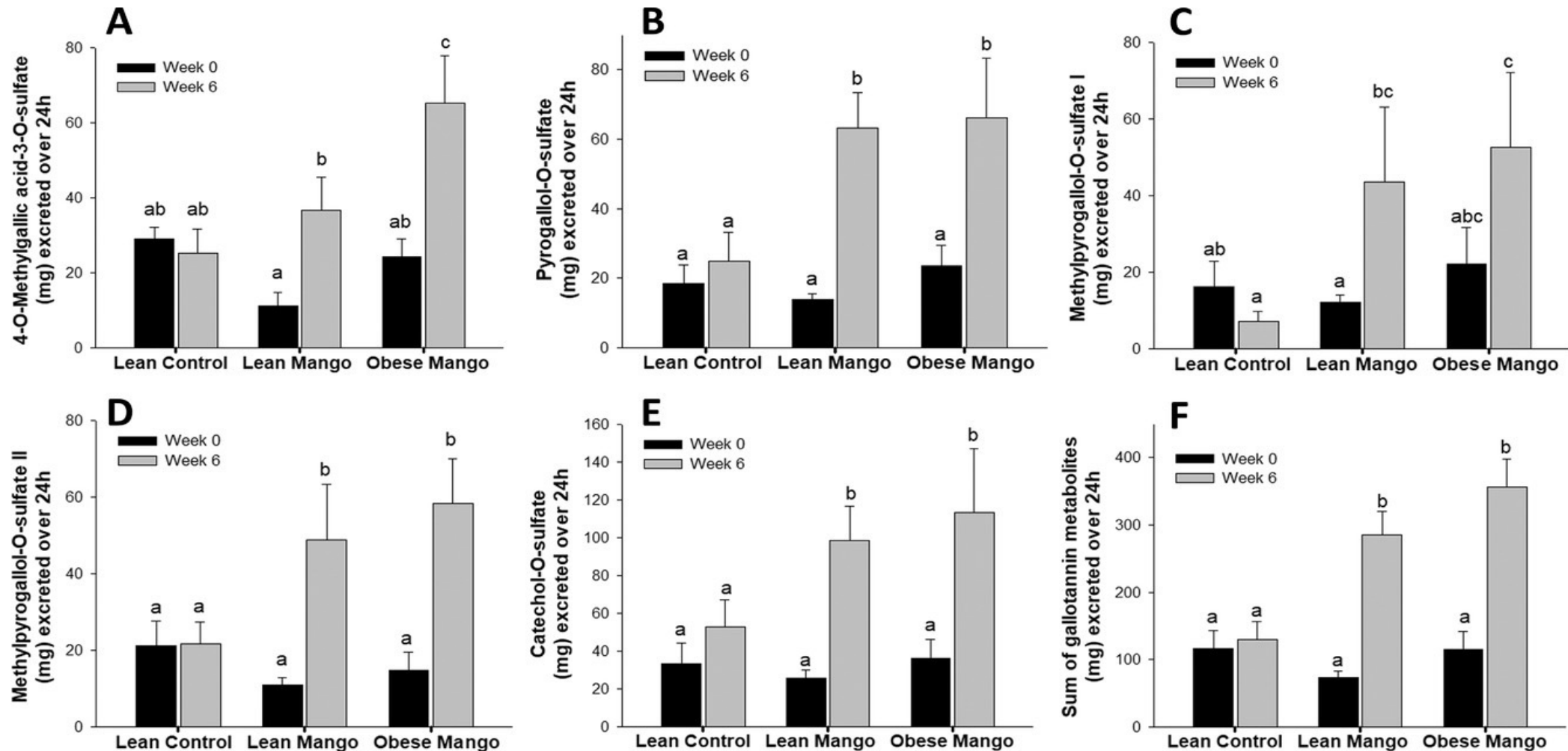
Urine Metabolites, Baseline



Urine Metabolites, 15th Day Fasting



Eating Mangos Daily for 6 Weeks Increases Select Metabolites Measured in Urine



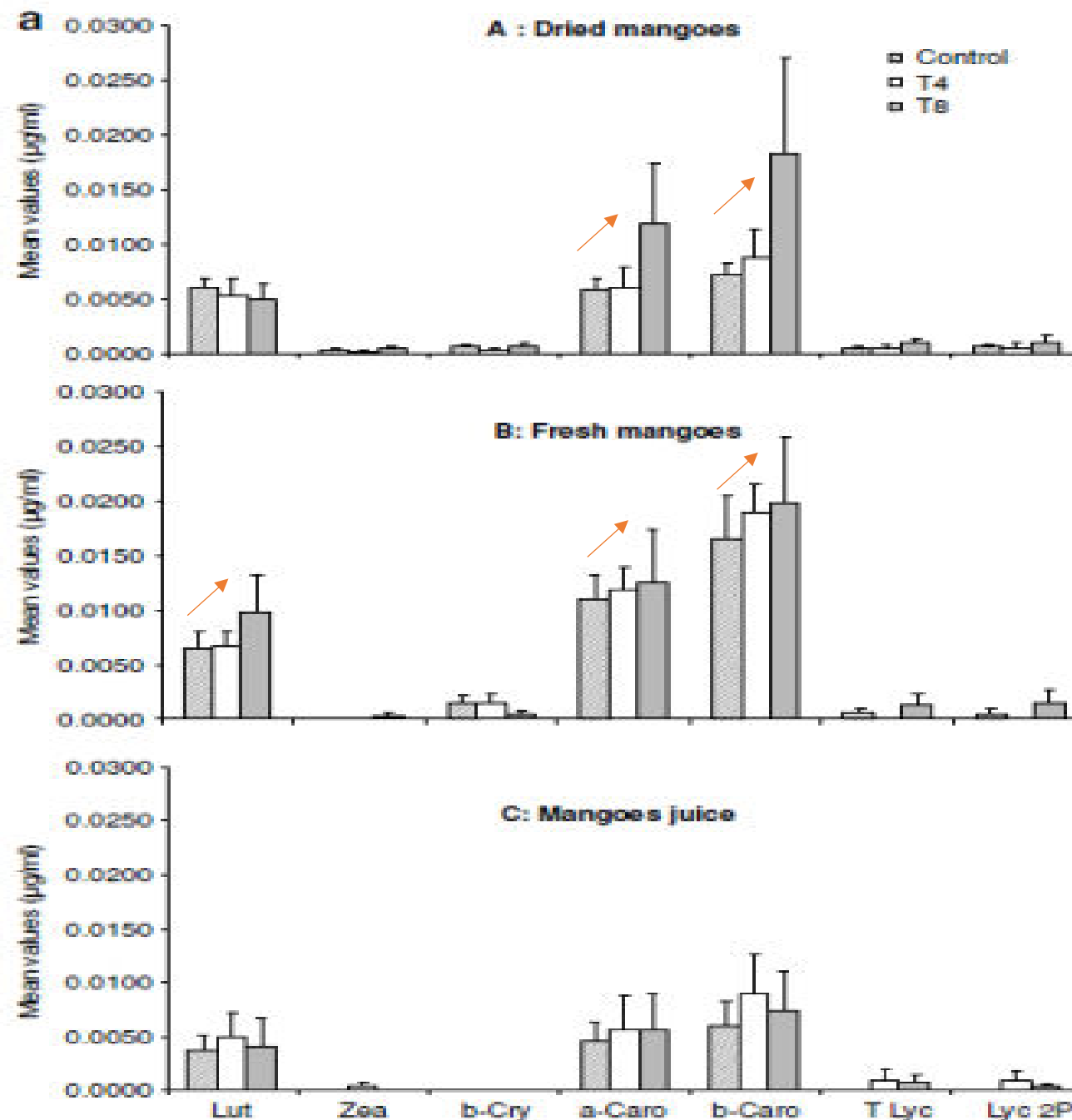
ORIGINAL ARTICLE

Systemic levels of carotenoids from mangoes and papaya consumed in three forms (juice, fresh and dry slice)

I Gouado¹, FJ Schweigert², RA Ejoh³, MF Tchouanguep⁴ and JV Camp⁵

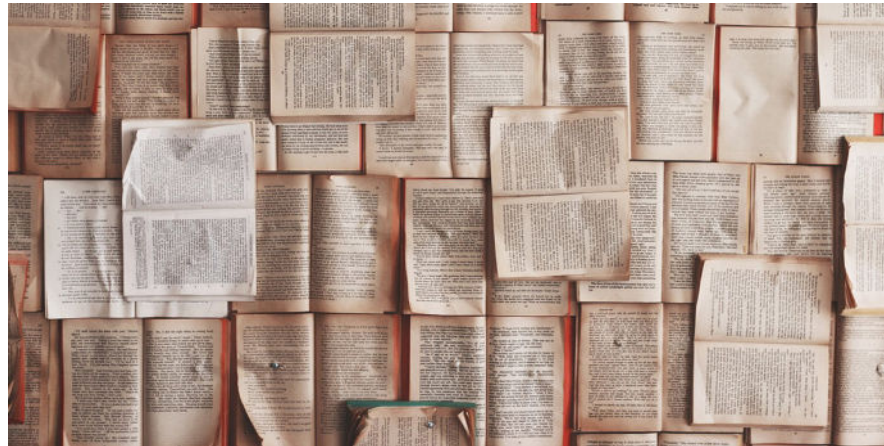
Carotenoid Bioavailability

Lutein
α carotene
β carotene



What Health Benefits Have Been Documented About **Mangos**?

Broad look at the literature



Evidence...



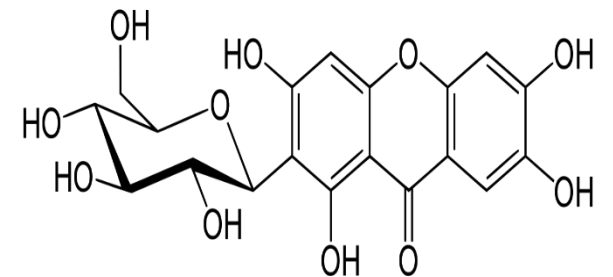
Whole Fruit



Fruit Product



Fruit/ Peel Extract



Isolated Fruit Compounds

Review of the Literature 2000-2016

Table 1: Database Summary: Biological models

Model ¹	# of Studies ²	Bioavail	Body Weight	Brain	Cancer	CVD	DM	GI	Skin	Anti-Inflam Ox
	n=	11	9	17	60	22	39	17	5	59
Human		2	1	0	0	1	9	0	0	2
Animal		5	6	12	25	16	26	17	2	25
Cell		3	2	7	48	4	7	6	3	37
Assays		2	1	0	0	2	3	0	1	4

Source: Mango Summary of Research Database, Up to July 2016

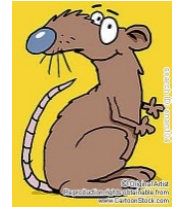
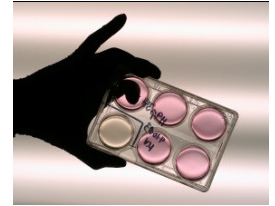
¹ Reflects models used in research studies; more than 1 model may have been used in a study

² Number of published articles (shown in bold)

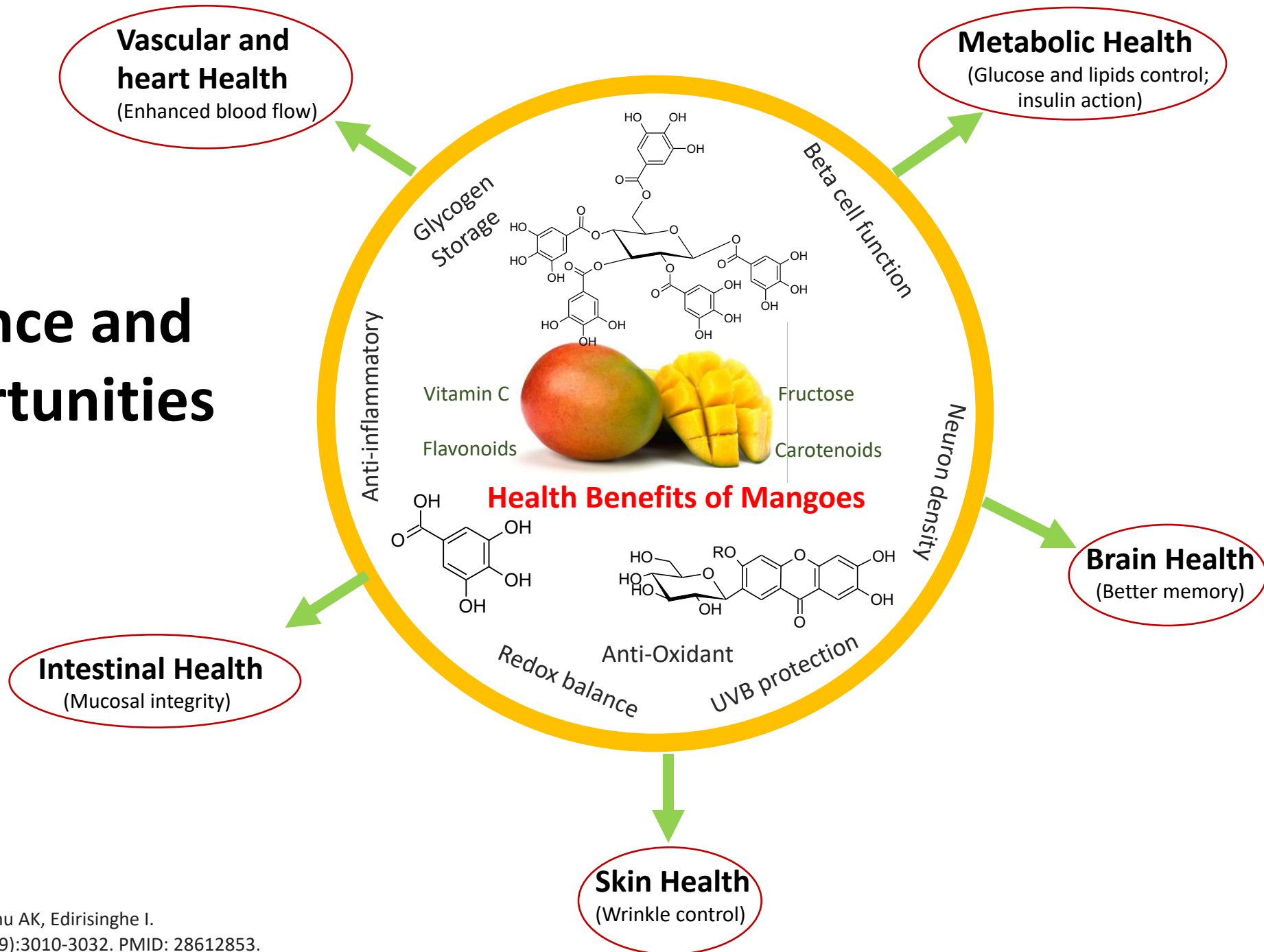
Phytochemical Compounds

Directly or Indirectly

- Anti-oxidant
 - Scavenge free radicals
 - Alter oxidative production
 - Enhance endogenous defenses against free radicals
- Anti- inflammation
- Alter cell signaling
- Enhance cell-to-cell communication
- Repair DNA or other tissue damage
- Detoxify carcinogens



Evidence and Opportunities



Nutritional Benefits Associated with Mango Intake



Article

Mango Consumption Is Associated with Improved Nutrient Intakes, Diet Quality, and Weight-Related Health Outcomes

Yanni Papanikolaou ^{1,*} and Victor L. Fulgoni III ² 

Mango Consumer vs Non-Consumers

Higher total and whole **fruit** intake

Higher dairy (children)

Higher seafood and plant protein (adults)

Higher fiber intake

Higher folate

Higher potassium

Less sodium

**OVERALL—Higher Healthy Eating Index
Adults and Children**

Table 3. Day 1 nutrient and energy intakes in mango non-consumers vs. mango consumers: adults aged 19+ years old.

Energy/Nutrients	Mango Non-Consumers		Mango Consumers		<i>p</i>
	Mean	SE	Mean	SE	
Energy (kcal)	2153	6.6	2194	53.2	0.452
Carbohydrate (g)	254	0.6	266	4.1	0.004
Added sugars (tsp eq)	17.5	0.2	14.9	0.8	0.001
Total sugars (g)	112	0.5	122	3.9	0.010
Protein (g)	83	0.3	80	3.3	0.334
Total fat (g)	84	0.2	82	2.0	0.285
Total MUFA (g)	29.5	0.1	29.5	1.1	0.988
Total PUFA (g)	19.5	0.1	18.7	0.6	0.155
Total SFA (g)	27.2	0.1	26.2	0.9	0.229
Cholesterol (mg)	293	1.9	259	16.4	0.042
Dietary fiber (g)	17.2	0.1	22.2	0.6	<0.0001
Calcium (mg)	982	5.0	1017	46	0.445
Folate, DFE (μg)	531	3.4	629	27.2	0.001
Iron (mg)	14.7	0.1	15.6	0.7	0.219
Lutein + zeaxanthin (μg)	1649	48.3	2096	460	0.330
Magnesium (mg)	307	1.5	347	10.7	0.001
Niacin (mg)	26.4	0.1	25.3	0.6	0.067
Phosphorus (mg)	1409	4.7	1423	60.7	0.816
Potassium (mg)	2696	12.0	2970	59.7	<0.0001
Riboflavin (Vitamin B2) (mg)	2.2	0.01	2.3	0.1	0.275
Sodium (mg)	3577	9.0	3246	106	0.003
Thiamin (Vitamin B1) (mg)	1.6	0.01	1.63	0.06	0.879
Total choline (mg)	338	1.4	330	15.6	0.628
Vitamin A, RAE (μg)	644	9.1	746	50.5	0.050
Vitamin B12 (μg)	5.2	0.1	4.7	0.2	0.018
Vitamin B6 (mg)	2.2	0.02	2.3	0.1	0.138
Vitamin C (mg)	80	1.2	141	7.5	<0.0001
Vitamin D (μg)	4.7	0.1	5.0	0.5	0.561
Vitamin E (mg)	9.1	0.1	11.2	0.5	0.0002
Zinc (mg)	11.4	0.1	11.2	0.4	0.628

Mean = least-square mean; SE = standard error; MUFA = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids; SFA = saturated fatty acids; vitamin D = D₂ + D₃; vitamin E = as α-tocopherol; DFE = dietary folate equivalents. NHANES 2001–2018.

Article

Mango Consumption Is Associated with Improved Nutrient Intakes, Diet Quality, and Weight-Related Health Outcomes

Yanni Papanikolaou ^{1,*} and Victor L. Fulgoni III ² 

Mango Consumer vs Non-Consumers

- Lower BMI
- Smaller waist circumference
- Lower body weight

Males and Mangos



Health Outcome	Sex	Mango Non-Consumers		Mango Consumers		<i>p</i>
		Mean	SE	Mean	SE	
Children, 14–18 years old						
BMI z-score	All	1.2	0.02	0.9	0.2	0.166
	Male	1.2	0.03	0.7	0.1	0.0001
	Female	1.1	0.03	1.4	0.3	0.327
Waist circumference (cm)	All	83.5	0.4	77.0	2.7	0.019
	Male	84.2	0.6	77.0	2.3	0.002
	Female	82.8	0.5	77.5	4.3	0.236
Body weight (kg)	All	69.5	0.5	62.9	3.4	0.060
	Male	73.6	0.7	67.2	4.5	0.151
	Female	65.2	0.6	59.8	4.8	0.263
Adults, 19+ Years Old						
BMI	All	29.2	0.1	28.9	0.9	0.766
	Male	29.0	0.1	26.9	0.6	0.001
	Female	29.4	0.1	30.3	1.4	0.516
Waist circumference (cm)	All	99.5	0.2	97.9	2.1	0.433
	Male	101.8	0.3	97.0	1.3	0.0004
	Female	97.2	0.3	97.7	3.3	0.888
Body weight (kg)	All	83.2	0.3	82.6	2.8	0.830
	Male	89.7	0.4	83.8	1.9	0.003
	Female	76.9	0.3	79.8	4.3	0.509

Mean = least-square mean; SE = standard error; BMI = body mass index; NHANES 2001–2018.

Mango and Body Weight

Primary outcome in response to eating mangos — none in humans

Secondary outcomes — humans

No data to support weight gain or weight loss when eating mangos
-generally neutral effect on body weight when monitored as secondary outcome

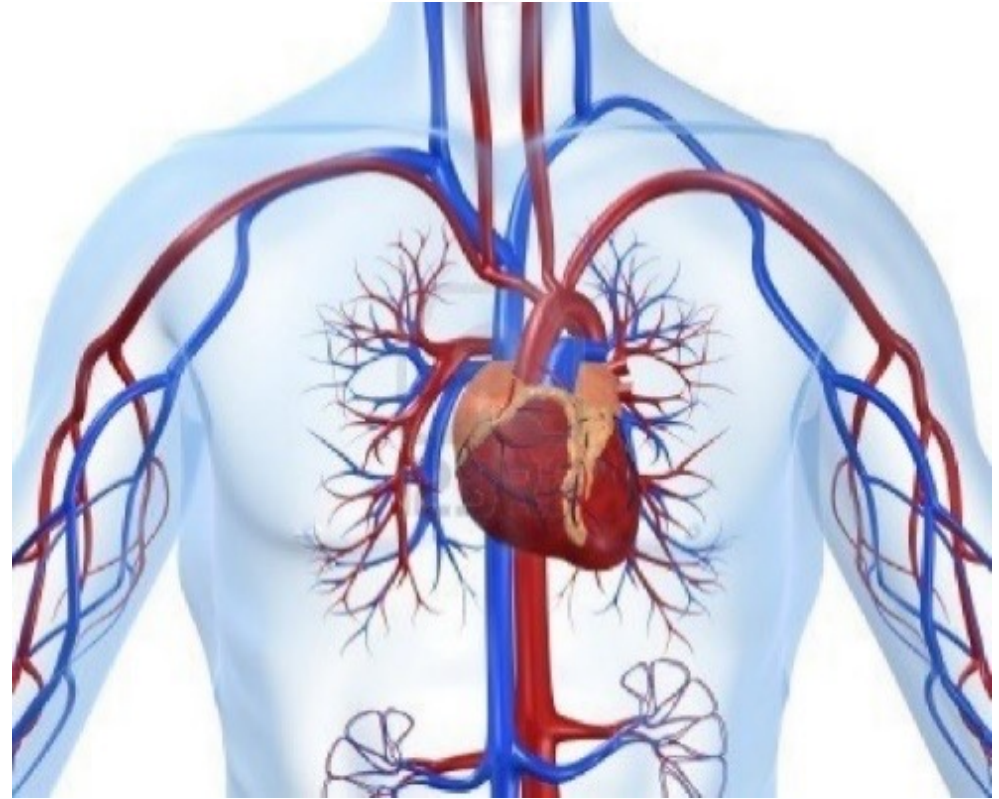
Satiety effects suggested compared to isocaloric cookie snack

Pinneo S, O'Mealy C, Rosas M Jr., et al. Journal of Medicinal Food. Apr 2022.381-388

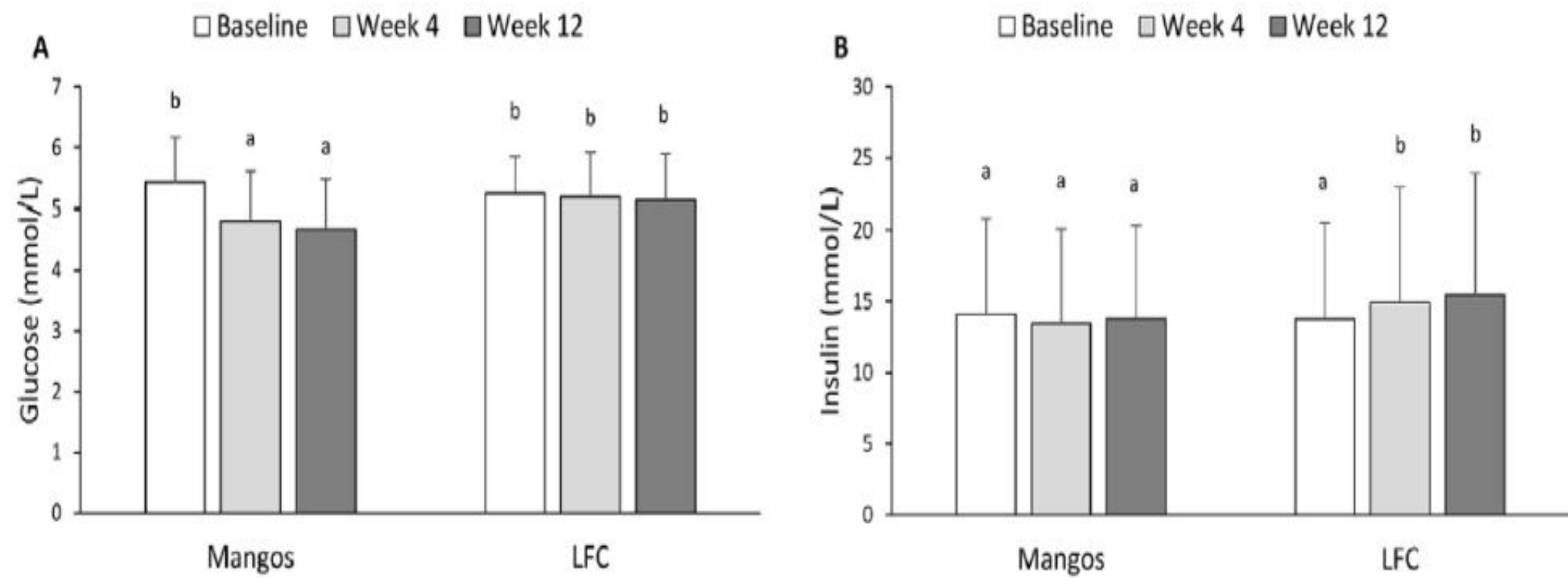
Evidence from animal studies suggest weight loss



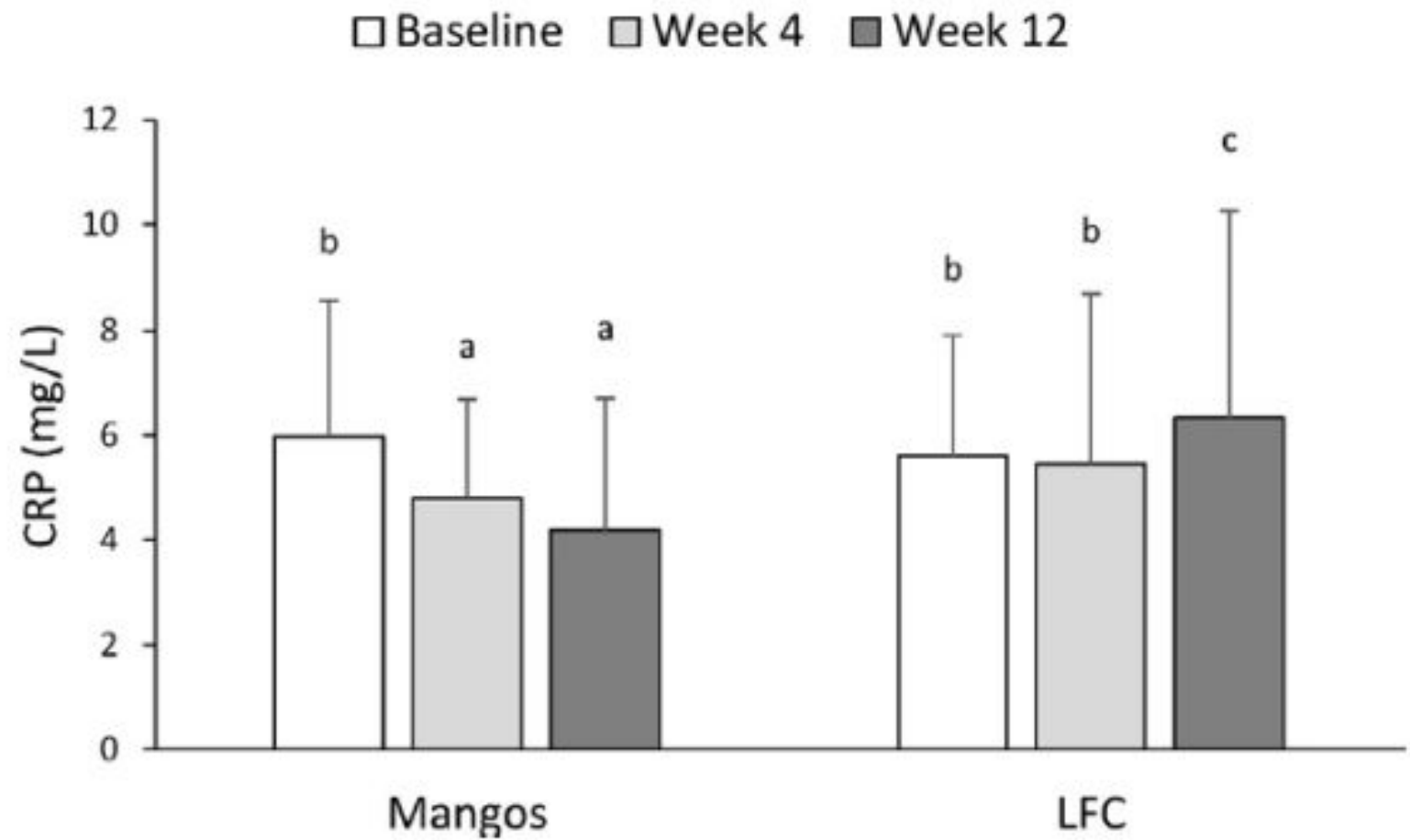
Cardio-Metabolic Effects of Mango Intake



Effects of Fresh Mango Consumption on Glucose and Insulin in Overweight and Obese Adults: **Mango Intake Reduces Glucose Concentrations**



Effects of Fresh Mango Consumption on Glucose and Insulin in Overweight and Obese Adults: **Mango Intake Reduces CRP, a Marker of Inflammation**



N=27
100 kcal: Mango or Cookie

Other outcomes:
BW – no change, mango
BW – increase, cookie
TG – no change mango
TG – increase cookie
Cholesterol – no change both

Effects of Fresh Mango Consumption for 8 Weeks in Overweight and Obese Adults: **Blood Pressure**

Table 4. Changes in blood pressure following 8-week mango supplementation.

Blood pressure (mm Hg)	Week 0	Week 4	Week 8
All participants			
SBP	117±1	116±2	113±2 ^{a,b} ↓
DBP	75±1	74±1	72±1 [#]
Males			
SBP	123±2	123±1	119±2
DBP	76±3	74±2	71±3
Females			
SBP	114±1	113±2	110±2 ^c ↓
DBP	75±1	74±2	73±1

Note: Values are presented as means ± standard deviation. Data were analyzed using general mixed linear models. DBP, diastolic blood pressure; SBP, systolic blood pressure.

[#] $p = 0.061$ compared with week 0.

^aSignificantly different from week 0 ($p = 0.01$).

^bSignificantly different from week 4 ($p = 0.03$).

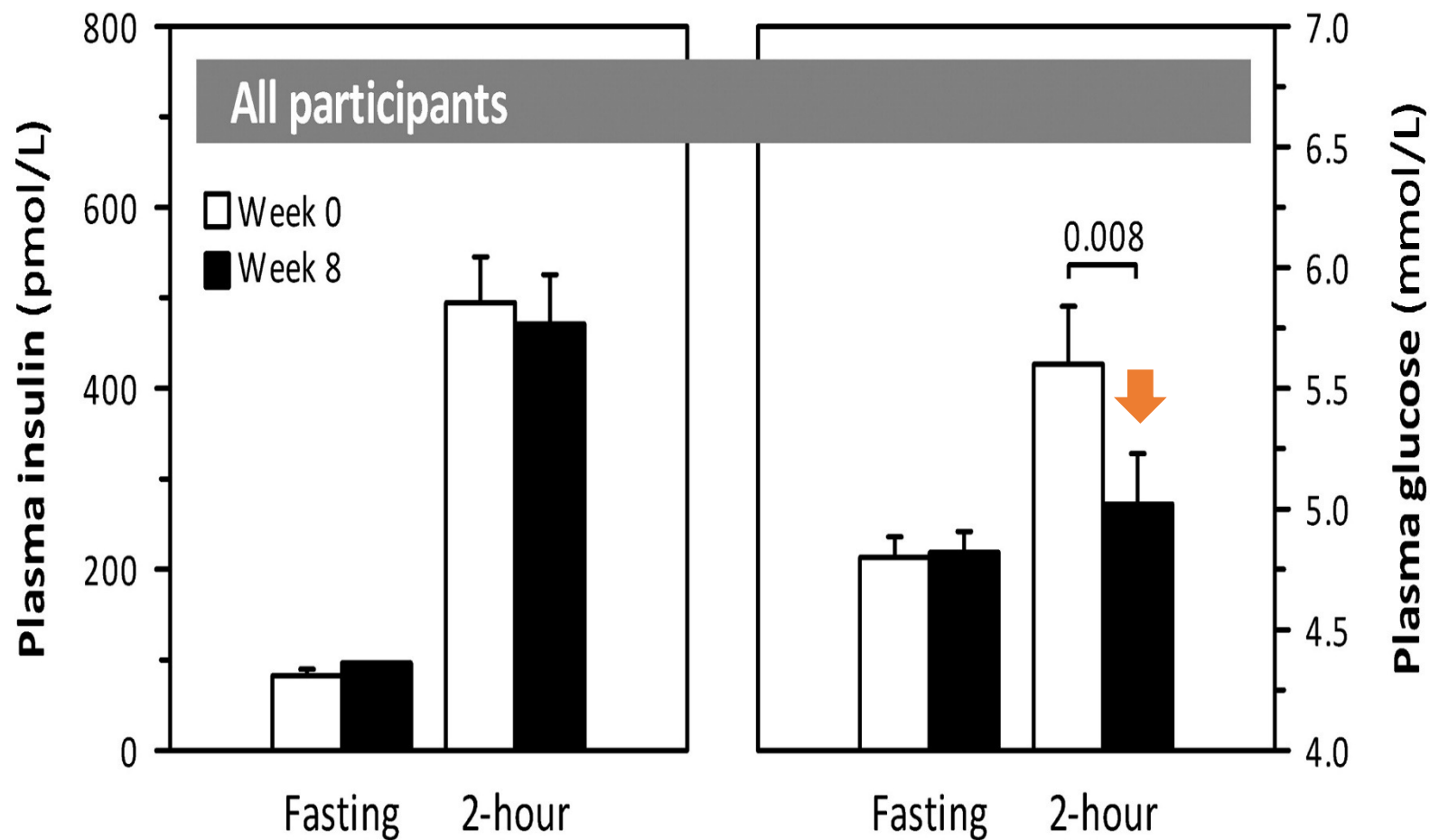
^cSignificantly different from week 0 ($p = 0.01$).

N=27
Mango, 280 g/d
~150 kcal/d

~ 30 y old
Insulin Resistant



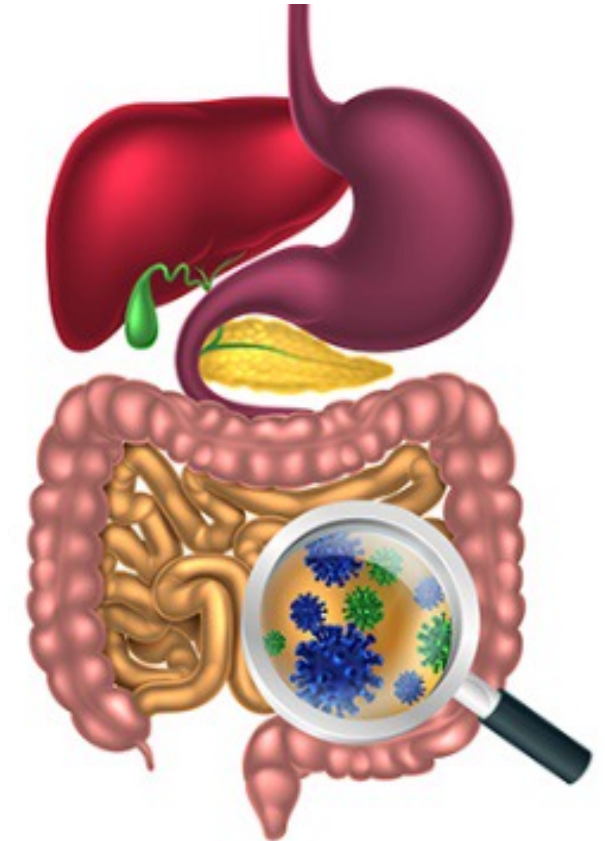
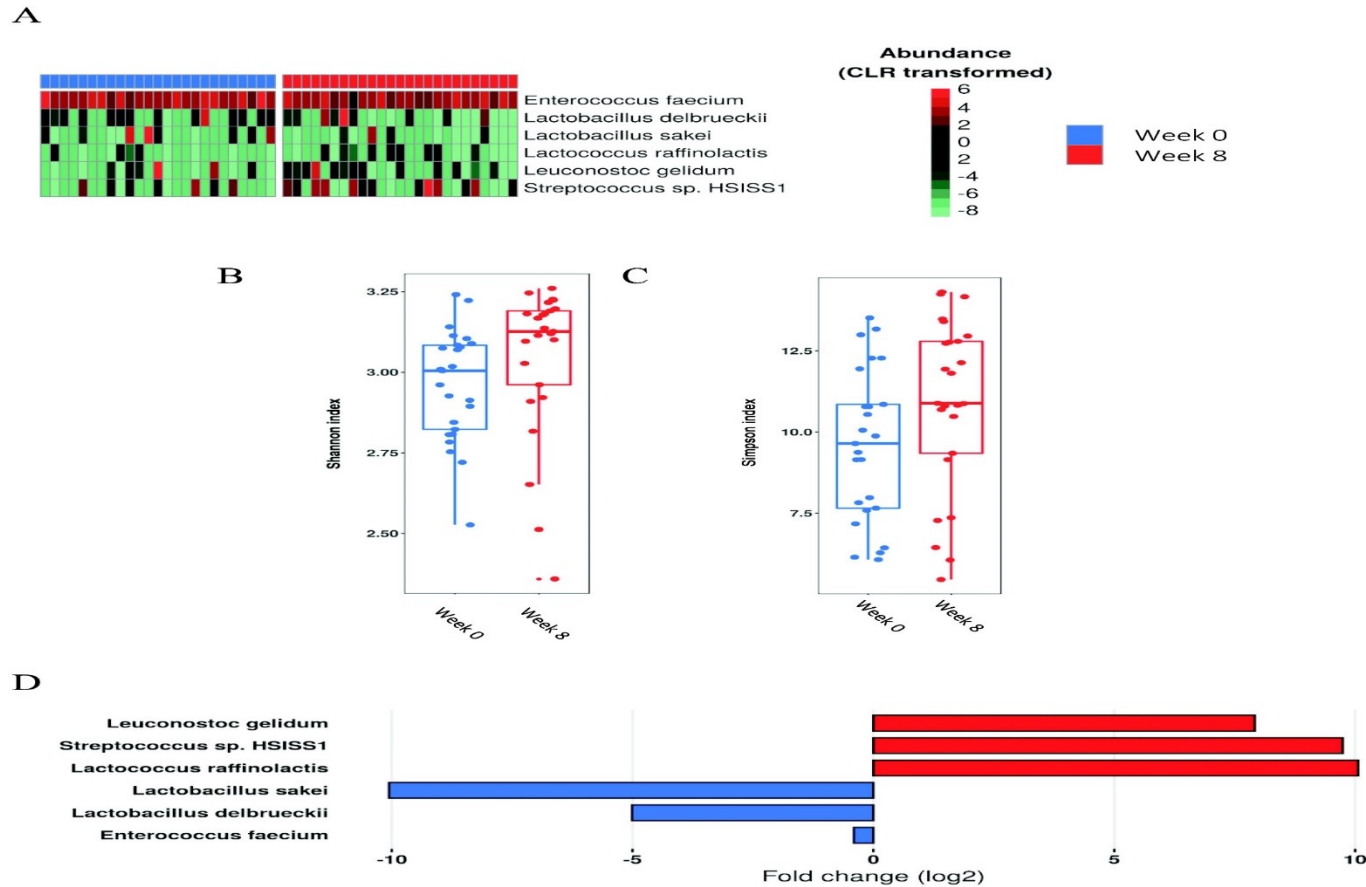
Effects of Fresh Mango Consumption for 8 Weeks in Overweight and Obese Adults: **Insulin and Glucose**



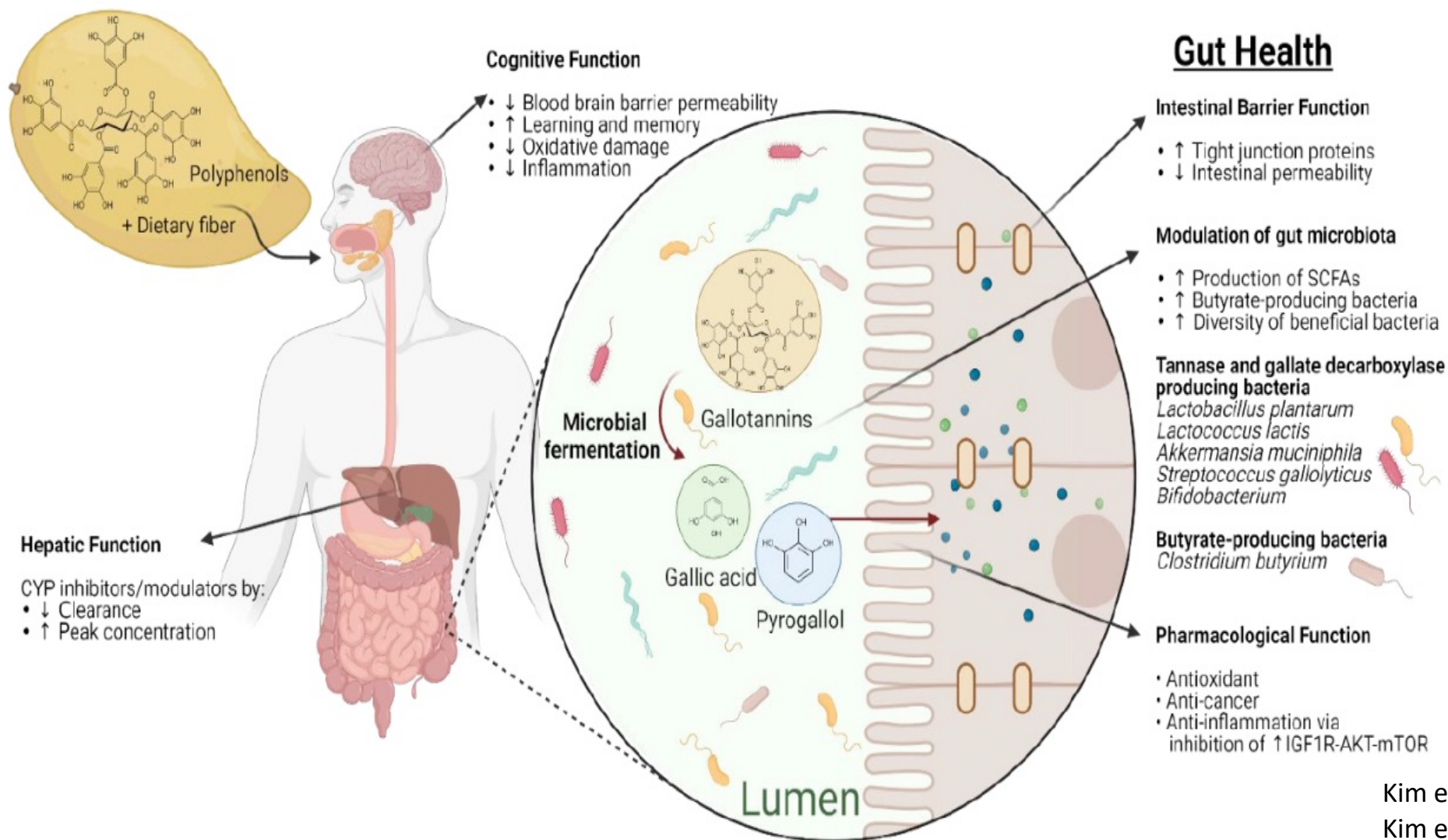
N=27
280 g a day for 8 weeks



Effects of Fresh Mango Consumption for 8 Weeks in Overweight and Obese Adults: Microbiota Composition

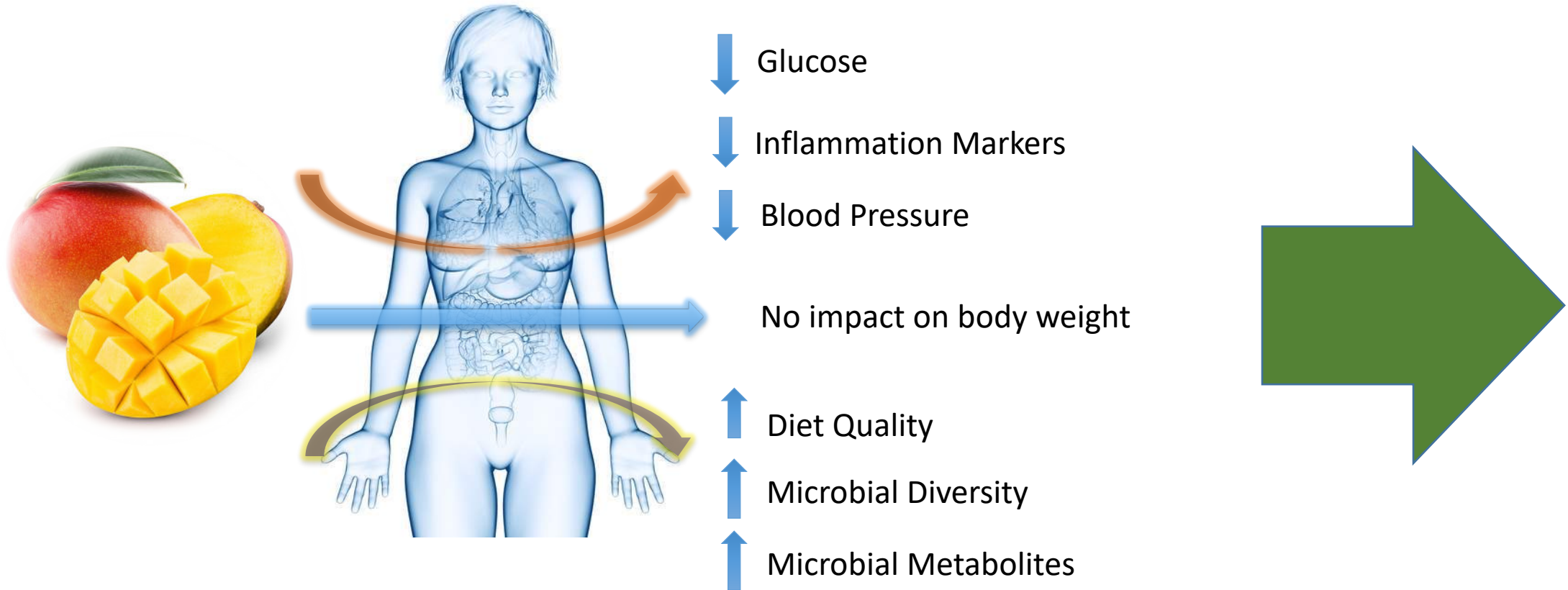


Additional Work on Microbiota Showing Promising Effects Influencing Health

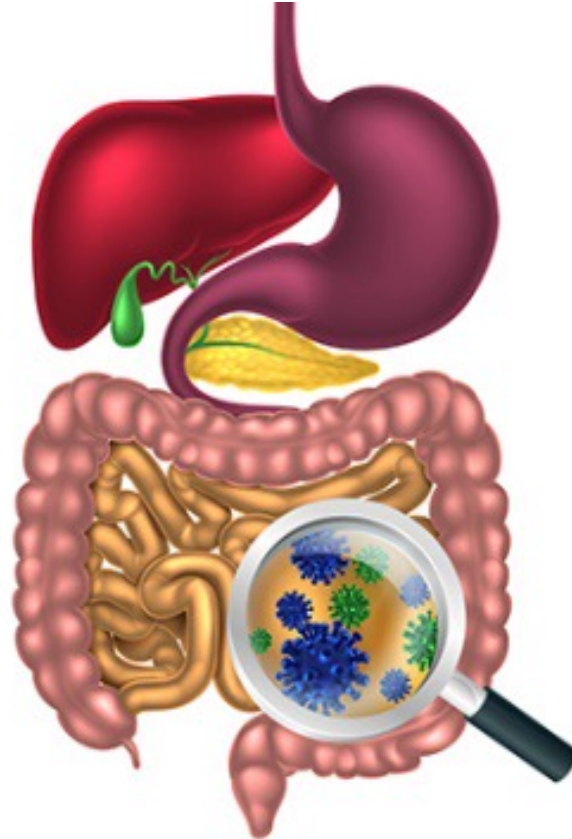


Kim et al Pilot study in IBD
Kim et al OW/OB

Mango Research Summary



Mango and Future Directions



Gut health

Integrity and function
Small and Large intestine
IBS, IBD, other



Cardio-Metabolic health

Dietary patterns research
Across life cycle
Improving bioavailability, exposure to metabolites



Brain health

Cognition, appetite regulation

Addressing Fruit and Fiber Gaps with Mango



To promote health and reduce chronic disease risk

The image features a vibrant orange background representing a sunset or sunrise. A large, bright yellow sun is positioned in the upper left corner. In the center, four black silhouettes of people are captured in mid-air, jumping joyfully with their arms raised. A white rectangular box is superimposed over the center of the image, containing the text "How to include more mango in the diet".

How to include more mango in the diet



THANK YOU

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