




Composition and Compositional Changes During Development: *Part I*




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I. Importance of Composition

- **In relation to human food**
 - **Nutritive value** - energy value, vitamins, minerals, protein, fiber, antioxidants
 - **Eating quality** - taste, aroma, texture
 - **Appearance** - color (pigment changes)
 - **Safety** - alkaloids, nitrates, mycotoxins



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Phytonutrients or Phytochemicals

TABLE 8.2
Common Phytonutrients, Potential Food Sources and Associated Postulated Health Benefits

Phytonutrient	Health benefit	Potential food sources
Flavonoids	Fights oxidation and blood clots	Apples, citrus fruits, cranberries, grapes, broccoli, celery, onions, tea, red wine
Carotenoids	Fights oxidation	Yellow/red fruits and vegetables: papaya, carrots, peppers, tomatoes, dark green leafy vegetables (e.g., spinach)
Allyl sulfides	May reduce blood cholesterol, helps liver detoxify carcinogens	Chives, garlic, leeks, onions
Isothiocyanates	May block carcinogens from damaging DNA	Cruciferous vegetables: broccoli, cabbage, sunflower
Indoles	May convert estrogen into less cancer-promoting form of the hormone	Cruciferous vegetables: broccoli, cabbage, sunflower
Terpenes	May help the liver to detoxify carcinogens	Citrus fruits: oranges, tangerines, limes, lemons
Isoflavones	May block entry of estrogen into cells, reducing the risk of breast, colon, or ovarian cancers; may alleviate menopausal symptoms	Soy




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I. Importance of Composition

- **In relation to postharvest requirements**
 - **Temperature** - e.g., starch-sugar conversions
 - **Light** - e.g., chlorophyll and solanine development
 - **Duration** of storage




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I. Importance of Composition

- **In relation to understanding metabolic processes**
 - Fruit softening and other processes associated with **ripening**
 - General **senescence** of various plant organs
 - **Physiological disorders**




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I. Importance of Composition

- **In relation to commercial practices**
 - **Maturity standards**
 - *e.g.*, melons, grapes, citrus, avocados, etc.
 - **Quality standards**
 - *e.g.*, watermelon.
 - **Raw-product evaluation of processing commodities**
 - *e.g.*, peas, corn, potatoes, onions, grapes, cling peaches, etc.
 - **Guidelines for the plant breeder**
 - *e.g.*, natural toxic substances (*i.e.*, solanine) vs. those classified by FDA as “GRAS” (“generally regarded as safe”).



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Per capita availability of fruits increased 13 percent between 1970 and 2005				Per capita availability of vegetables increased 23 percent between 1970 and 2005					
Item	Per capita availability ¹		Change, 1970 to 2005	2005 loss-adjusted food availability ²	Item	Per capita availability ¹		Change, 1970 to 2005	2005 loss-adjusted food availability ²
	1970	2005				1970	2005		
	Pounds, fresh-weight equivalent	Percent		Cups/day		Pounds, fresh-weight equivalent	Percent		Cups/day
Citrus, melons, and berries ^{3,4}	138.8	136.4	-2	0.36	Dark-green vegetables ^{3,4}	3.8	20.2	425	0.16
Citrus	113.7	101.2	-11	.26	Leafy lettuces ⁵	.6	10.9	1,856	.08
Fresh	28.8	21.6	-25	.06	Broccoli	1.5	8.3	446	.04
Processed (juice)	84.9	79.6	-6	.20	Deep-yellow vegetables ^{3,4}	15.0	21.4	43	.10
Melons ³	21.6	25.8	19	.05	Carrots	9.5	11.9	24	.06
Watermelon	13.5	13.8	2	.03	Sweet potatoes	5.4	4.5	-17	.02
Cantaloup	7.2	10.1	40	.02	Other starchy vegetables ^{3,4}	155.5	155.5	--	.63
Berries ³	3.5	8.9	156	.05	Potatoes	121.7	125.6	3	.55
Fresh and frozen strawberries	2.9	7.7	163	.03	Corn	27.8	26.9	-3	.06
Other fruits ^{3,4}	101.9	136.0	36	.57	Other vegetables ^{3,4}	154.9	210.5	36	.80
Fresh bananas	17.4	25.1	45	.08	Head lettuce	22.4	21.1	-6	.12
Fresh apples	17.2	16.9	-1	.12	Canned tomatoes	62.1	73.6	18	.13
Fresh grapes	2.9	8.6	197	.04	Garlic	.4	2.4	450	.01
Apple juice	6.4	22.5	254	.07	Fresh tomatoes	12.1	20.2	66	.07
Grape juice	2.4	5.6	136	.02	Fresh onions	10.1	21.0	107	.07
Canned applesauce	5.7	4.3	-24	.07	Cucumbers	8.5	10.2	20	.03
Canned olives	1.0	1.4	48	.03	Bell peppers	2.2	7.1	227	.03
Canned peaches	6.8	3.3	-50	.01	Cabbage	11.0	9.3	-15	.06
Raisins	5.8	7.3	25	.02	Celery	7.3	5.9	-19	.04
Total fruits	240.7	272.4	13	.92	Total vegetables	336.8	414.6	23	1.72

Source: Dietary assessment of major trends in U.S. food consumption, 1970-2005. EIB-33. USDA ERS, 2008



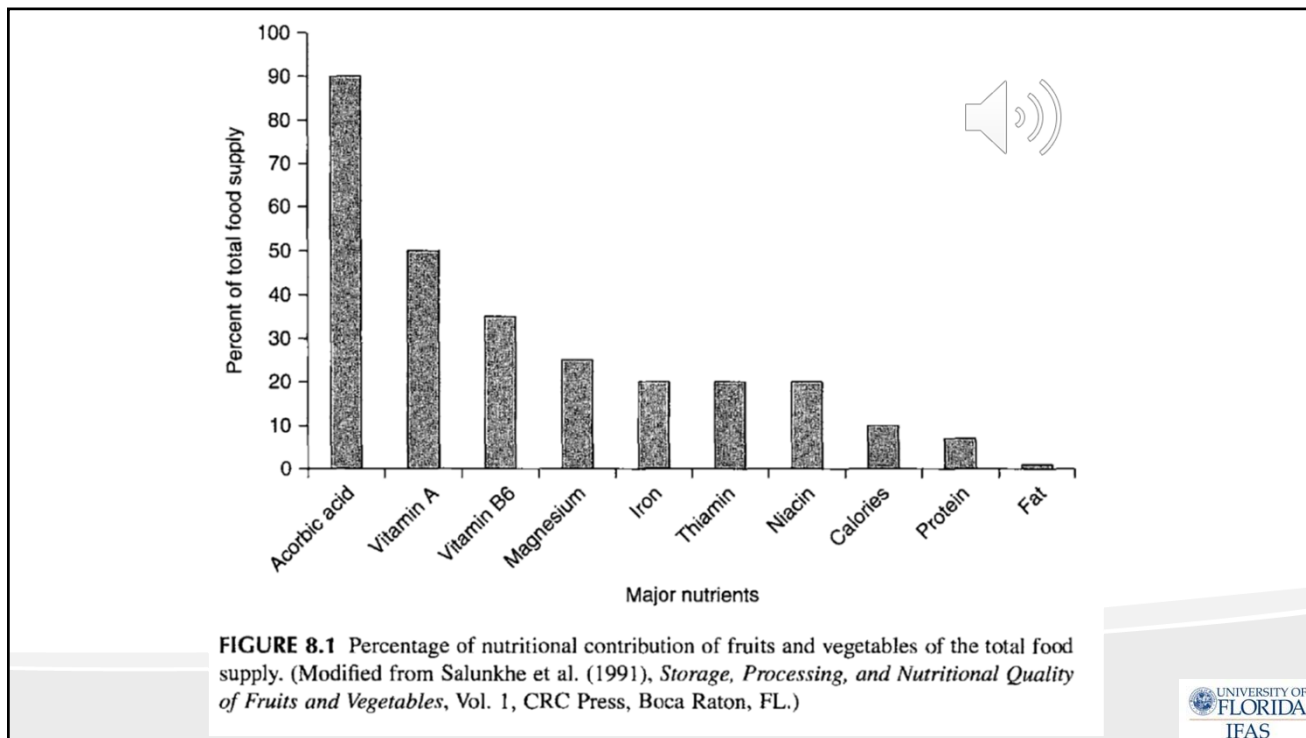
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II. Fruits and Vegetables as Foods

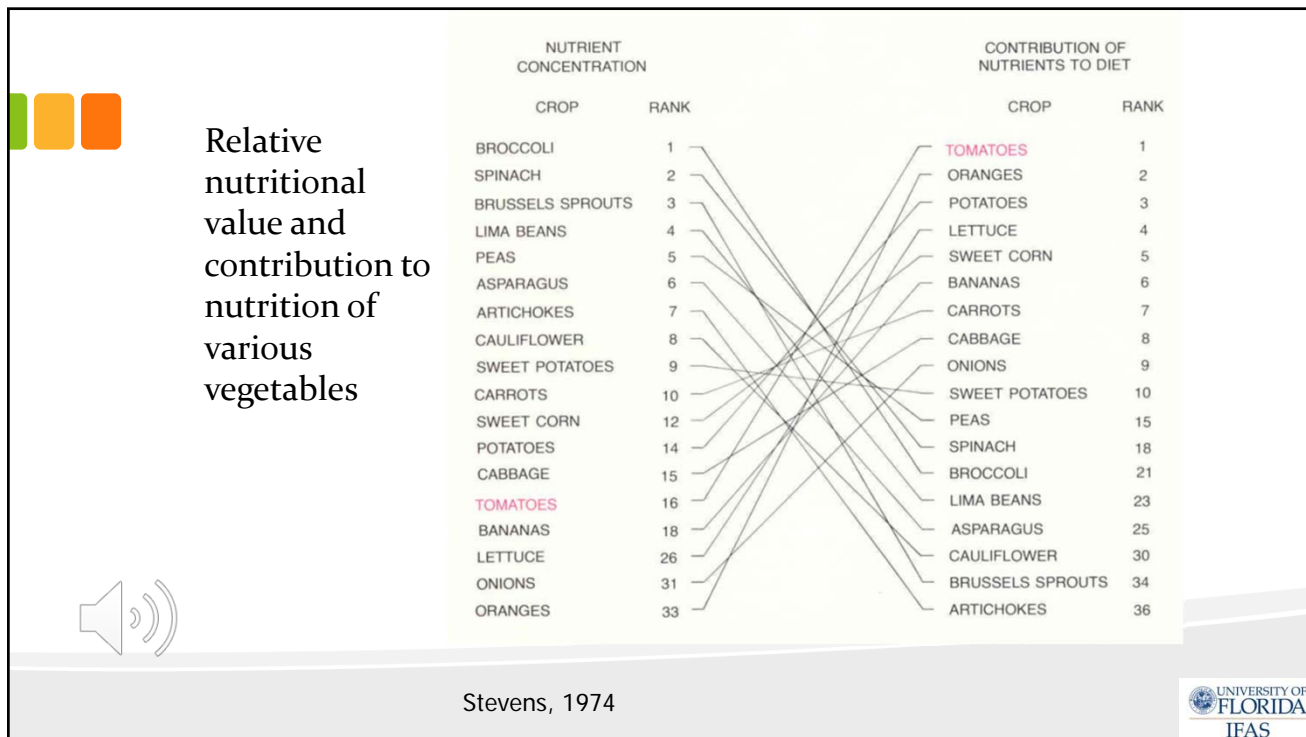
- **Energy (calories)**
 - Carbohydrate foods - cassava, potato, sweetpotato, yam, taro, breadfruit, green banana, plantain, jackfruit.
 - Fat foods - avocado, olive, nuts.
- **Proteins and amino acids**
 - Legumes, nuts.
- **Vitamins, minerals, dietary fiber and antioxidants**
 - Most fruits and vegetables.



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Contribution of Constituents to Quality Attributes of Fruits and Vegetables

Constituent	Level (%)	Structure	Contribution		
			Flavor	Food Value	Appearance
Water	75-95	X	X	X	X
Carbohydrates	2-25	X	X	X	
Protein	1-8	X	?	X	
Lipids	<1	X	X	X	X
Organic acids	<1		X	X	
Amino acids			X	X	
Pigments			?	X	X
Vitamins			?	X	
Minerals (ash)			X	X	
Volatiles			X	X	



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III. Factors Influencing Composition

- **Genetic:** selection of cultivars and rootstocks
- **Preharvest environmental factors:**
 - **Climatic:** temperature, light, pollutants, etc.
 - **Cultural:** soil type, nutrient and water supply, thinning, spacing, etc.
 - **Harvesting stage:** maturity, ripeness, physiological age
- **Postharvest treatments:** environmental factors, handling methods, duration between harvesting and consumption, etc.



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Ranges in tuber nutrient composition among potato varieties

	mg/150 g fresh wt.	% of U.S. RDA	Range
Protein	1050-8850	2.4-19.65	8.4X
Ascorbic acid	12.00-45.00	19.95-75.00	3.8X
Thiamine	0.051-0.219	3.45-14.55	4.3X
Riboflavin	0.015-0.078	0.90-23.25	5.2X
Niacin	0.81-4.65	4.05-23.25	5.7X
Folacin	0.0075-0.015	3.75-7.50	2X
Vitamin B ₆	0.195-0.63	9.75-31.50	3.2X
Calcium	4.50-24.00	0.45-2.40	5.3X
Magnesium	16.50-45.00	4.20-11.25	2.7X
Iron	0.20-1.80	1.05-10.35	9X
Copper	trace-0.60	0-3.45	---
Phosphorus	27.00-96.00	2.70-9.60	3.6X



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Composition of tomato fruit grown with normal or high fertilizer levels

Fertilizer	pH	Total acid (%)	Soluble solids (%)	Total solids (%)	Brix acid ratio
Normal ^z	4.35	0.287	4.96	5.22	17.5
High ^y	4.34	0.335	5.14	5.43	15.5
LSD@5%	NS	0.015	0.17	0.18	1.3

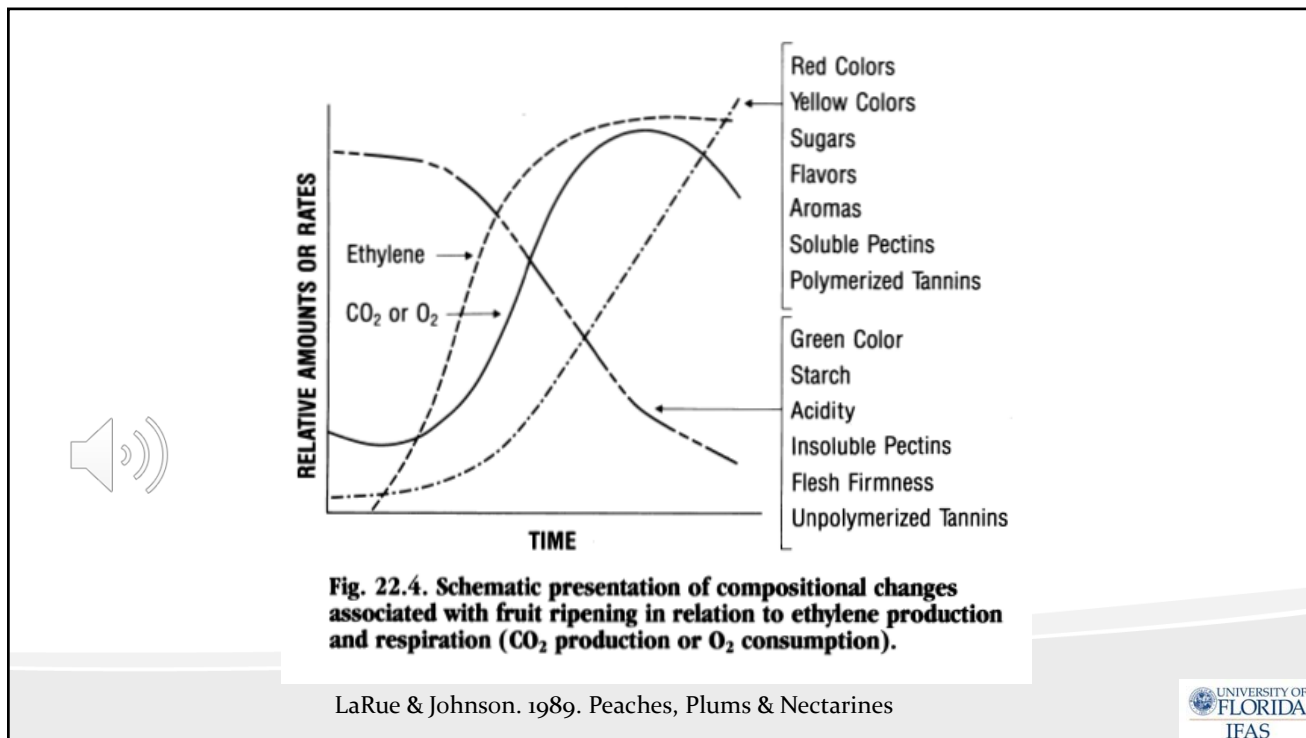
^zTotal of 72-43-81 lb per acre of N-P-K, respectively.

^yTotal of 142-83-158 lb per acre of N-P-K, respectively.

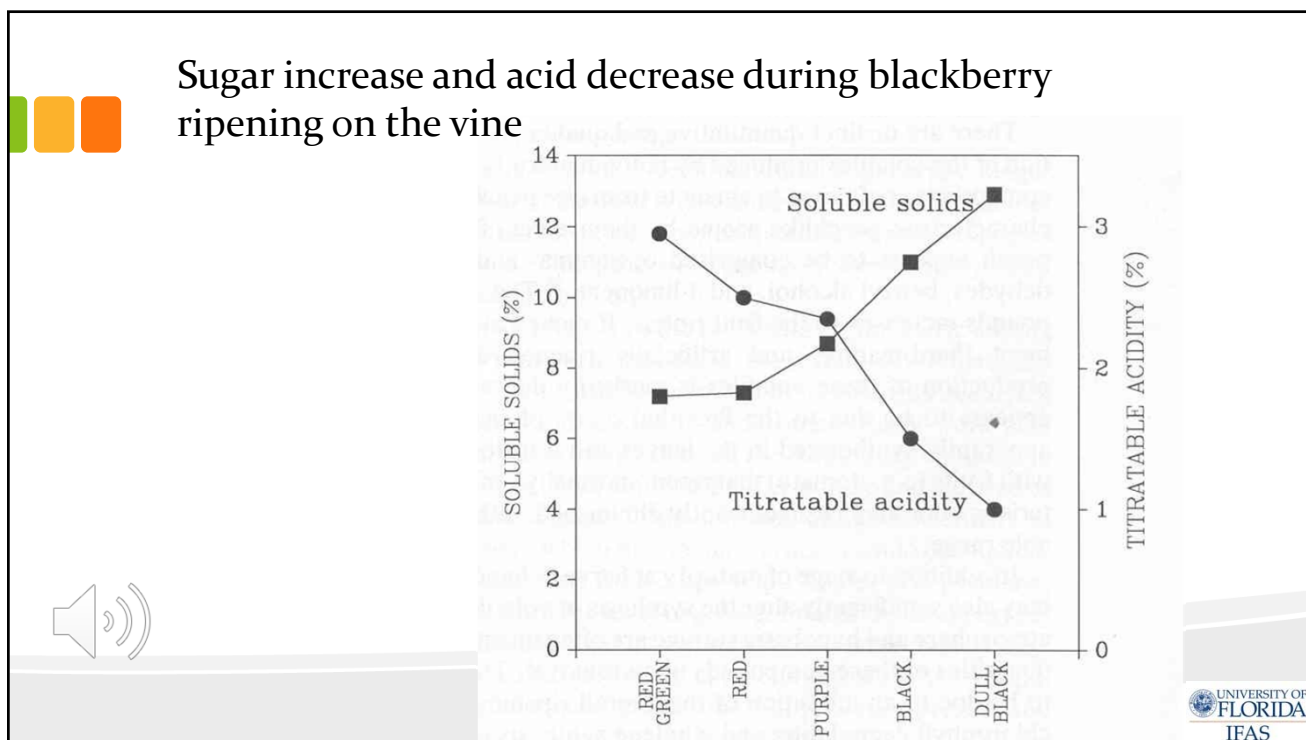


Vittum et al., 1962

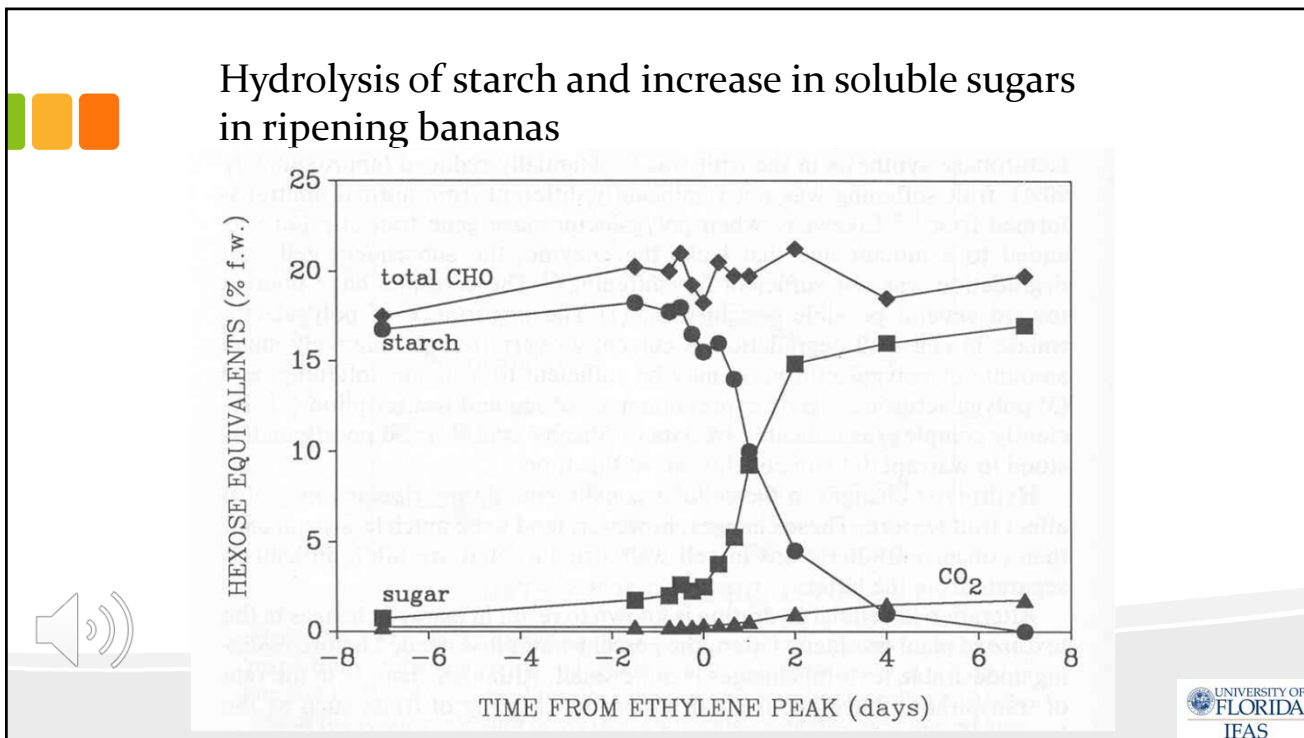
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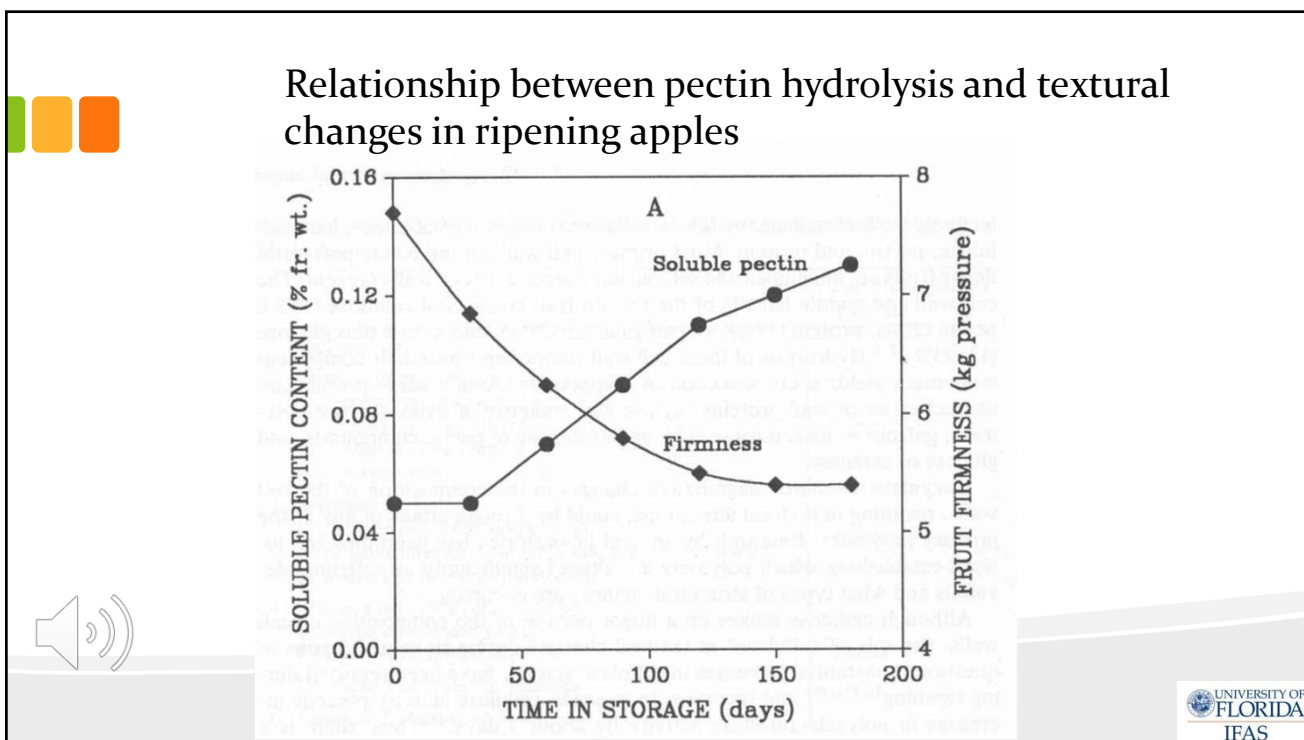
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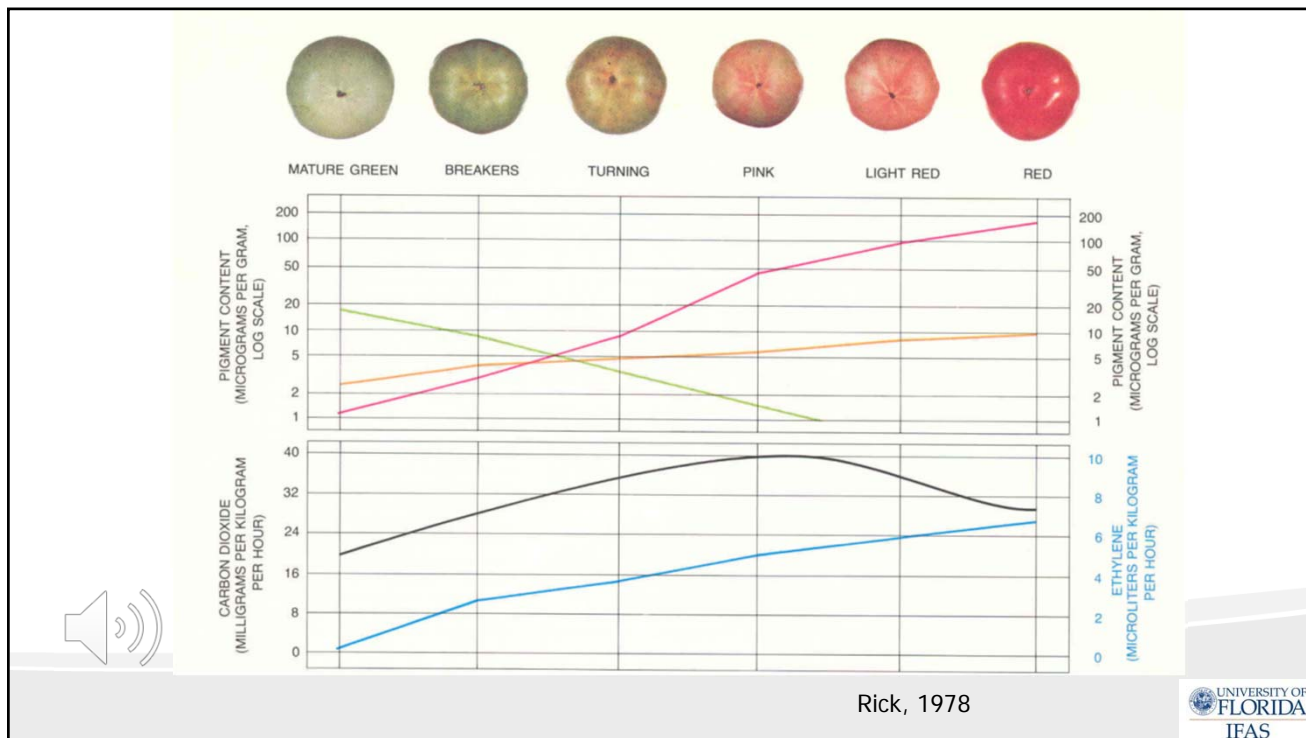
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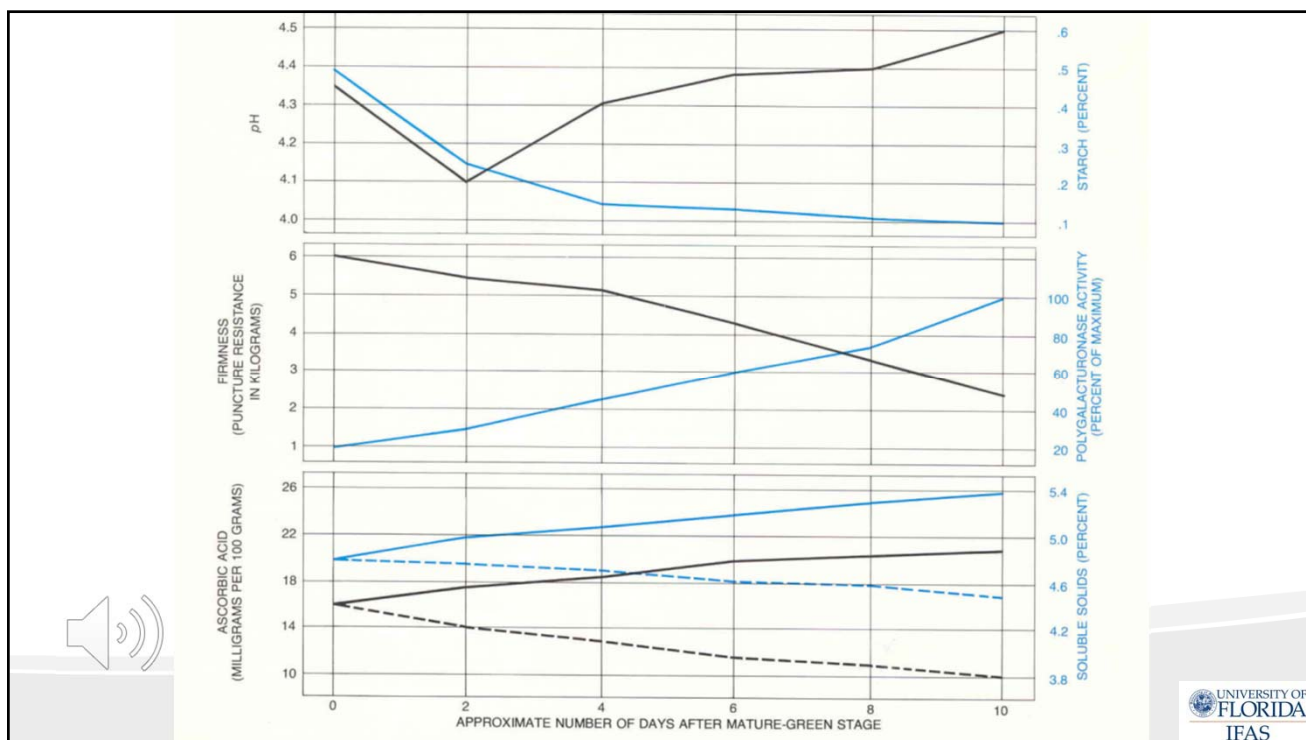
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Effects of delaying cooling for 6 hours at 30C on composition of strawberries after storage for 1 week at 1C plus 1 day at 20C

Treatment 'Cultivar'	pH	Titratable acidity (%)	SSC (%)	Ascorbic acid (mg/100 g)	Sugars		
					Fruc	Gluc (g/100 g)	Suc
No delay to cooling							
'Sweet Charlie'	3.52 a	5.87 b	54.49 b	485.4 a	8.19 b	6.19 b	0.79 b
'Oso Grande'	3.48 a	5.49 c	50.69 b	483.1 a	10.84 b	6.95 b	0.84 b
'Chandler'	3.39 b	6.79 a	60.38 a	453.5 a	16.35 a	10.79 a	5.86 a
Average	3.46A	6.05A	55.12A	474.0A	11.79A	7.97A	2.49A
6 h delay to cooling							
'Sweet Charlie'	3.51 a	5.16 b	48.86 ab	411.5 a	8.45 b	6.99 b	0.27 c
'Oso Grande'	3.51 a	4.77 b	45.24 b	412.1 a	10.81 a	8.44 a	1.67 b
'Chandler'	3.39 a	5.62 a	49.04 a	380.1 a	4.71 c	2.18 c	2.69 a
Average	3.47A	5.18B	47.05B	401.2B	7.99B	5.87A	1.54A



Nunes et al., 1995

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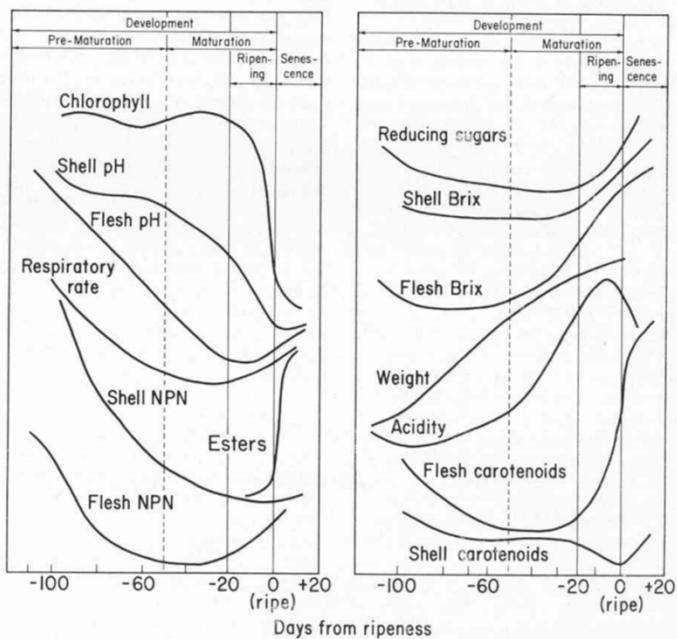
IV. Compositional Changes During Development

- Essential to determining the optimum horticultural (harvest) maturity
- Important in relating sensory characteristics to composition of the commodity
- Important in developing means of controlling the rate of compositional changes



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Physicochemical properties of pineapple fruit during development

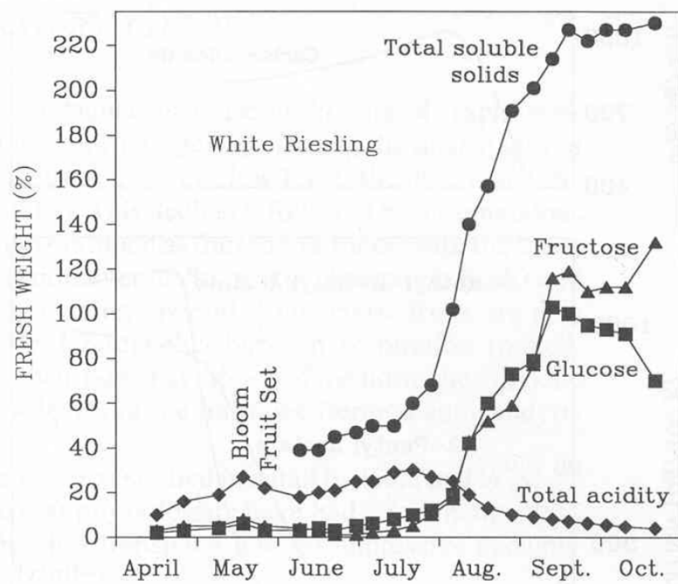


Gortner et al., 1967



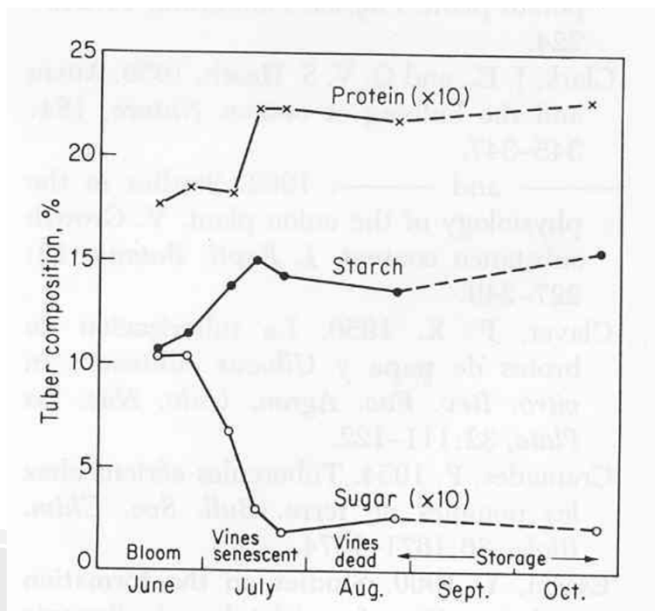
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Sugar accumulation during grape ripening on the vine



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Potato tuber compositional changes associated with vine senescence



Appleman and Miller, 1926



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End of Composition: *Part I*



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