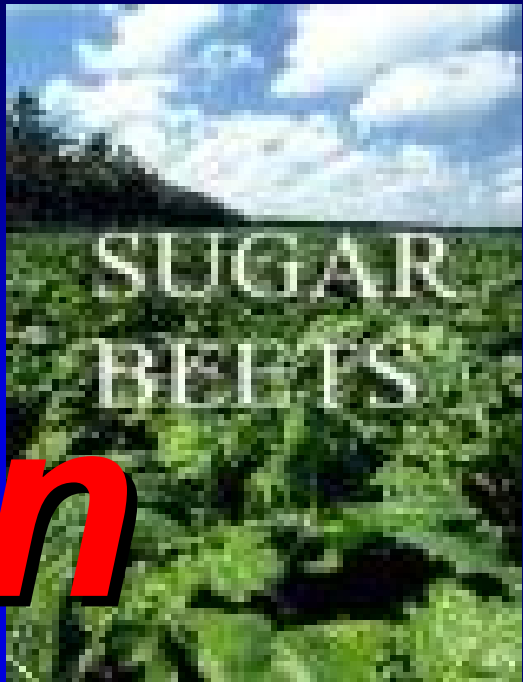


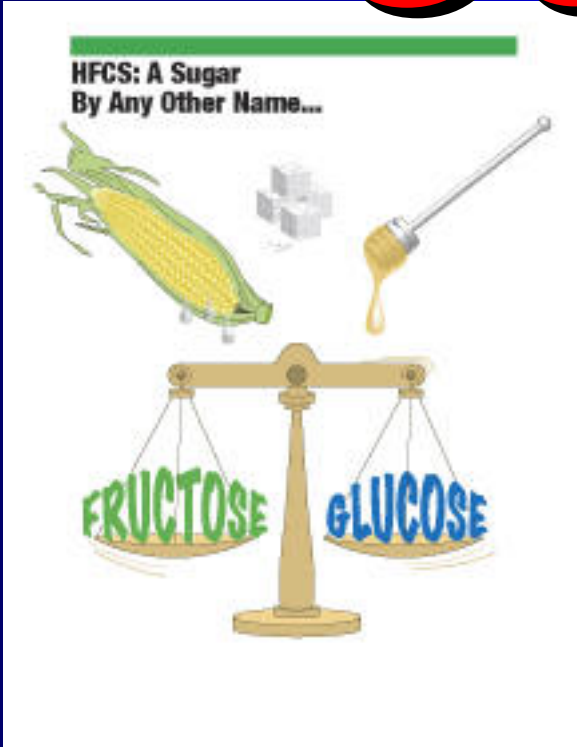
High Fructose Corn Syrup versus Sugar: Nutrition Issues and Concerns

**USDA, Agriculture Outlook Forum
February, 27, 2009**

**Eric Hentges, PhD
Executive Director, ILSI North America**



Confusion



Discussion Outline

- **Fructose and sweetener statistics**
- **Fructose versus Glucose**
- **HFCS versus Sucrose**

State-of-the-Science on Dietary Sweeteners Containing Fructose

**Workshop
18-19 March 2008
Beltsville, MD**

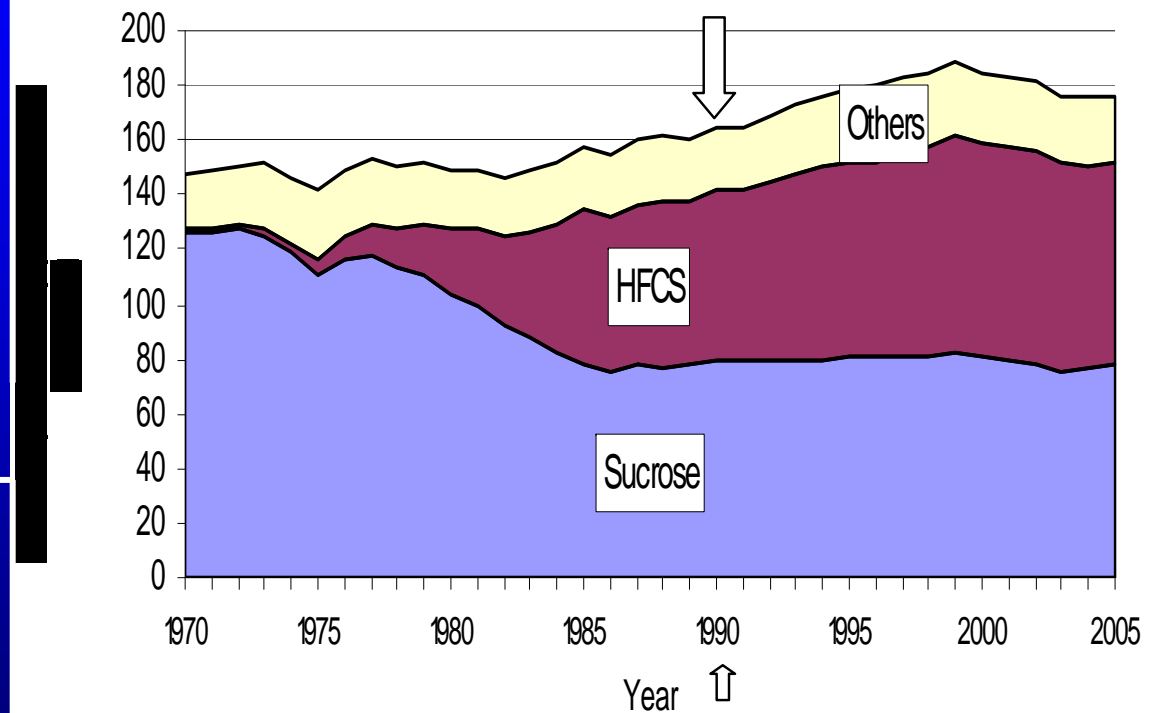
Funding Sources:

**ILSI-NA Technical Committee on Carbohydrates
American Beverage Association
Corn Refiners Association
Calorie Control Council
USDA/ARS (in-kind)**

ERS Disappearance Data

Year	Total (g/d)	Suc (<-----% total----->)	HFCS	Other
1970	148	85	0.5	14
1975	142	78	4	17
1980	149	73	12	15
1985	157	50	36	14
1990	165	49	37	14
1995	179	45	40	15
2000	185	44	42	14
2005	176	44	42	14

Per capita disappearance data on a dry weight basis (g/ day):
1970 - 2005



Sweetness Relative to Sucrose*

<u>Substance</u>	<u>Relative Sweetness</u>
<u>Fructose</u>	<u>117</u>
<u>High fructose syrup – 90</u>	<u>106</u>
<u>Sucrose</u>	<u>100</u>
<u>High fructose syrup – 55</u>	<u>99</u>
<u>High fructose syrup – 42</u>	<u>92</u>
<u>Glucose</u>	<u>67</u>

* From Hanover and White. Am J Clin Nutr 1993;58:724S.

Food Supply Availability-Energy

	1970	2004	Δ
<i>Total energy</i>			
Kcal/day	3,200	3,900	+700
<i>Caloric sweeteners</i>			
lb/year	119.1	141.6	+22.5
% of energy	18.4	17.3	-1.1
% Sucrose	85.4	43.5	-41.9
% HFCS	0.5	42.2	+41.7

Fructose Food Sources

NHANES 1999–2004

Food Group	Added	Total
	<i>% of mean daily intake</i>	
Milk & milk products	4–14	4–12
Fruits & fruit products	<3	8–38
Grain products	11–32	10–25
Sugars & sweets	8–15	7–12
Nonalcoholic beverages	36–73	25–66

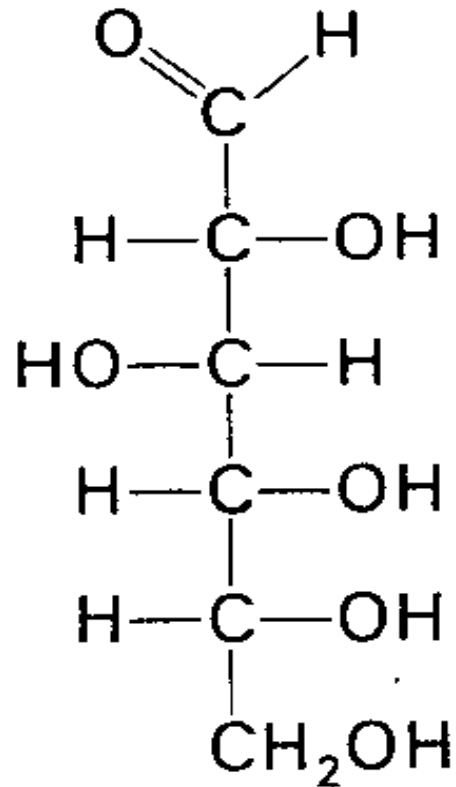
Dietary Fructose Intake

NHANES 1999–2004

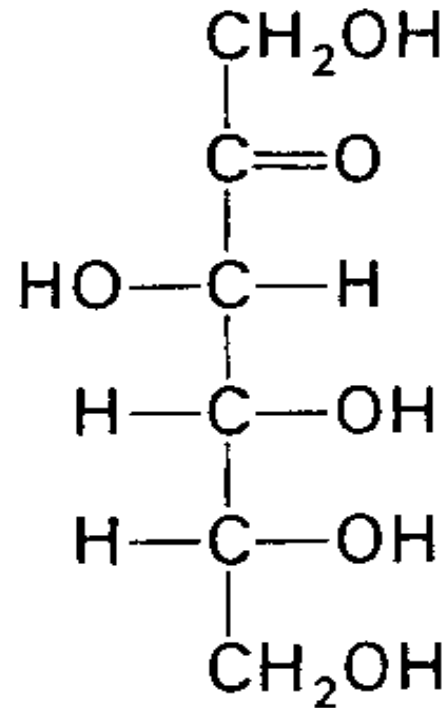
	Added	Total
<i>g/day</i>		
Population mean	41	49
Highest mean (M 15–22 y)	67–68	75
Highest 90 th percentile (M 19–22 y)	107	117
<i>% of kcal</i>		
Population mean	7.5	9.1
Highest mean (M&F 15–22 y)	10	11–12
Highest 90 th percentile (F 19–22)	15	16

So what is the confusion?

Glucose vs Fructose



D-Glucose
(An aldose)



D-Fructose
(A ketose)

Dietary Fructose Reduces Circulating Insulin and Leptin, Attenuates Postprandial Suppression of Ghrelin, and Increases Triglycerides in Women
KL Teff. J Clin Endocrinol Metab 2004;89:2963-2972.

12 normal weight, healthy women consumed for one day meals providing 30% of energy as fructose and, on another day, 30% of energy as glucose. Blood samples were collected every 30-60 minutes. On the days after the fructose and glucose study days, *ad libitum* energy intake was monitored.

AUC above baseline (Teff,et al.)

	High Glucose Diet	High Fructose Diet	P value
Plasma Glucose (mmol/L x 23 h)	43.4 + 5.2	23.9 + 3.7	< 0.003
Plasma TG (g/L x 23 h)	-2.1 + 1.6	13.8 + 6.4	< 0.01
Plasma Insulin (pmol/L x 23 h)	6,658 + 496	3,262 + 309	< 0.001
Plasma Leptin (ng/ml x 24 h)	301 +31	219 + 23	< 0.01
Plasma GLP-1 (pg/ml x 23 h)	46 +20	113 + 33	< 0.01

Teff, et al (cont.)

Hunger ratings were not different between high glucose and high fructose diets.

Ad libitum food intakes on days 2 were not different.

Sucrose vs HFCS

Short-term Responses of Postprandial Triglycerides, Uric Acid, and endocrine mediators of Energy Balance following Consumption of High Fructose Corn Syrup or Sucrose Beverages with Meals.

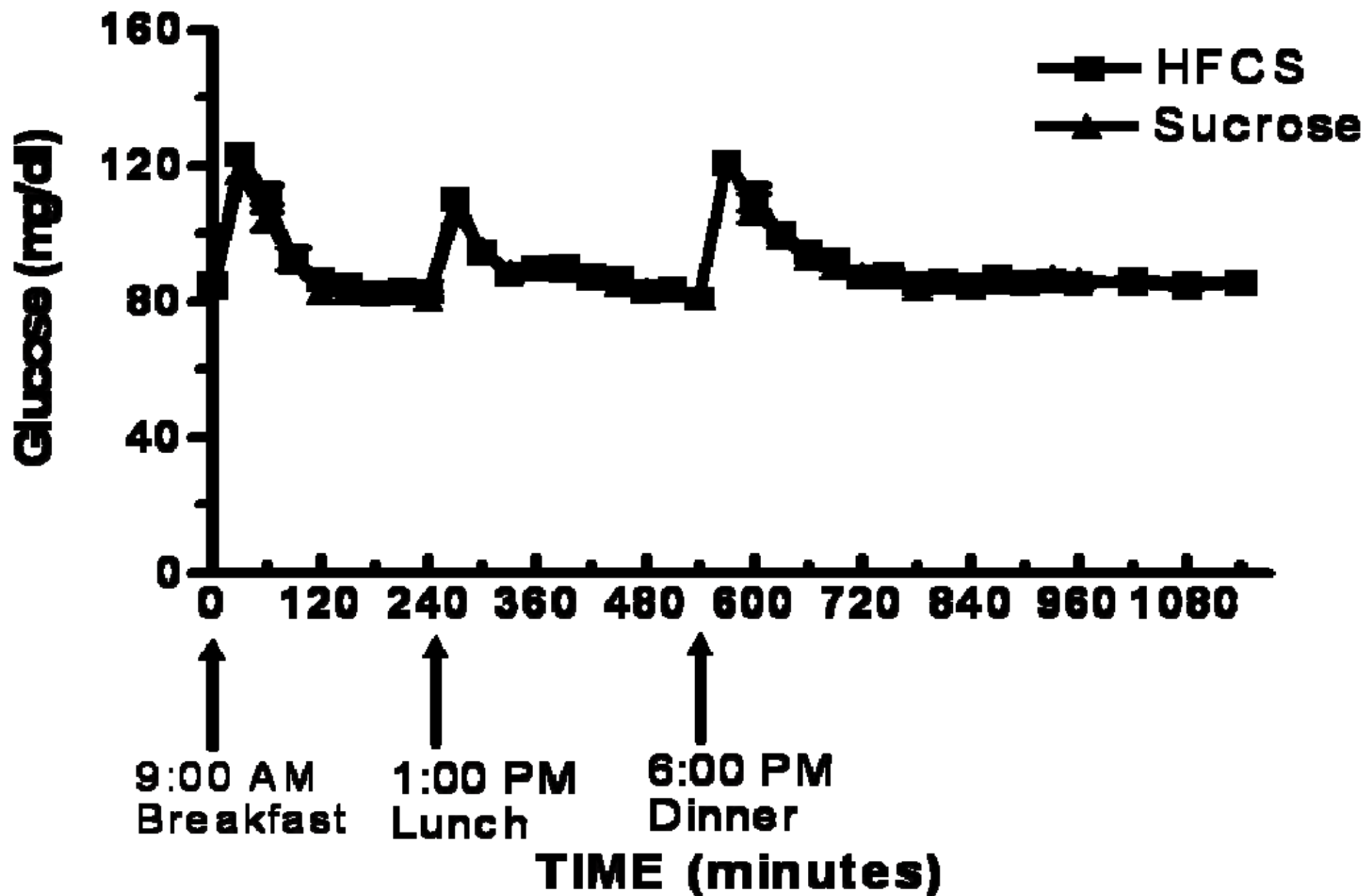


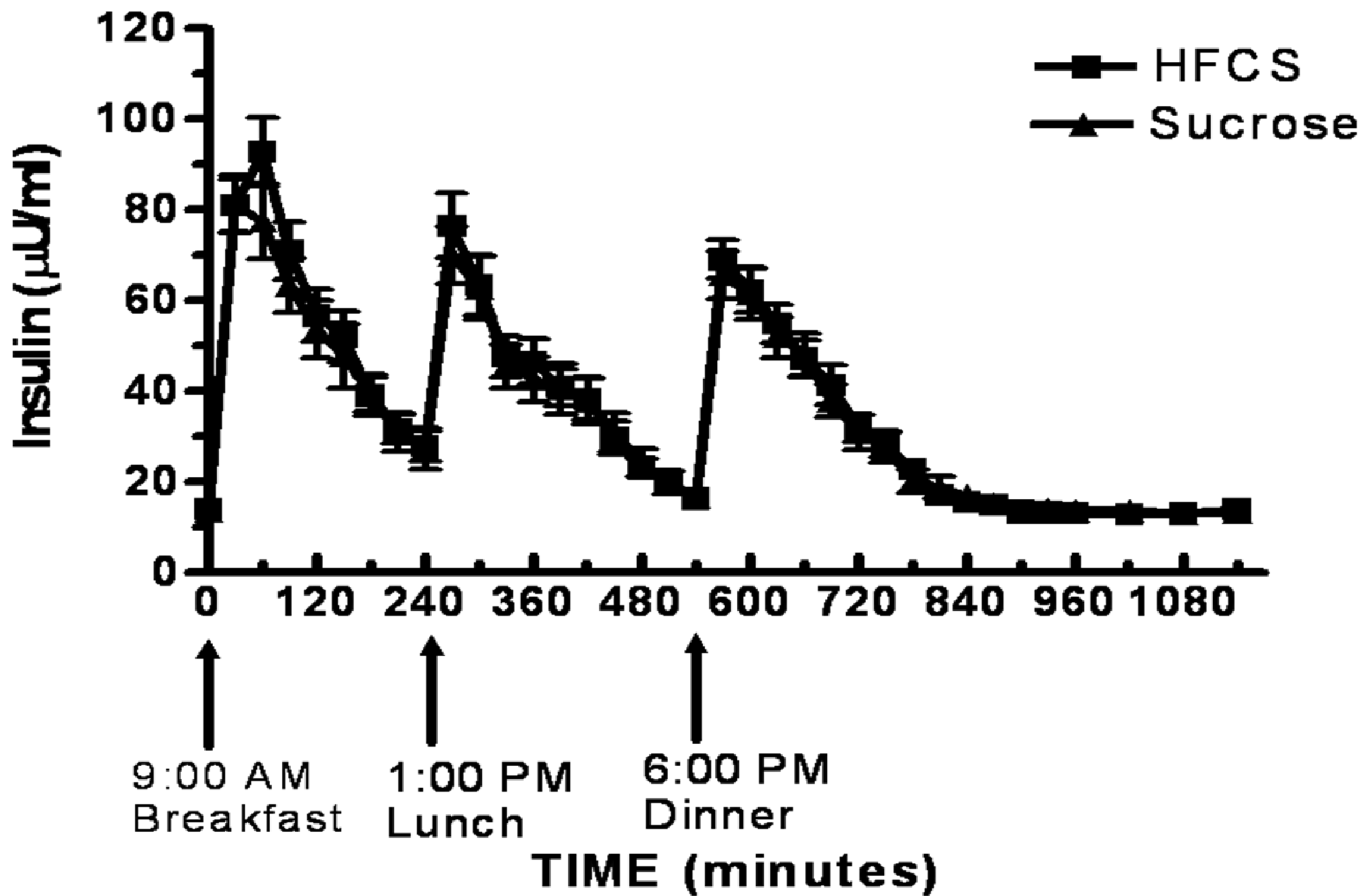
Rippe Lifestyle Institute

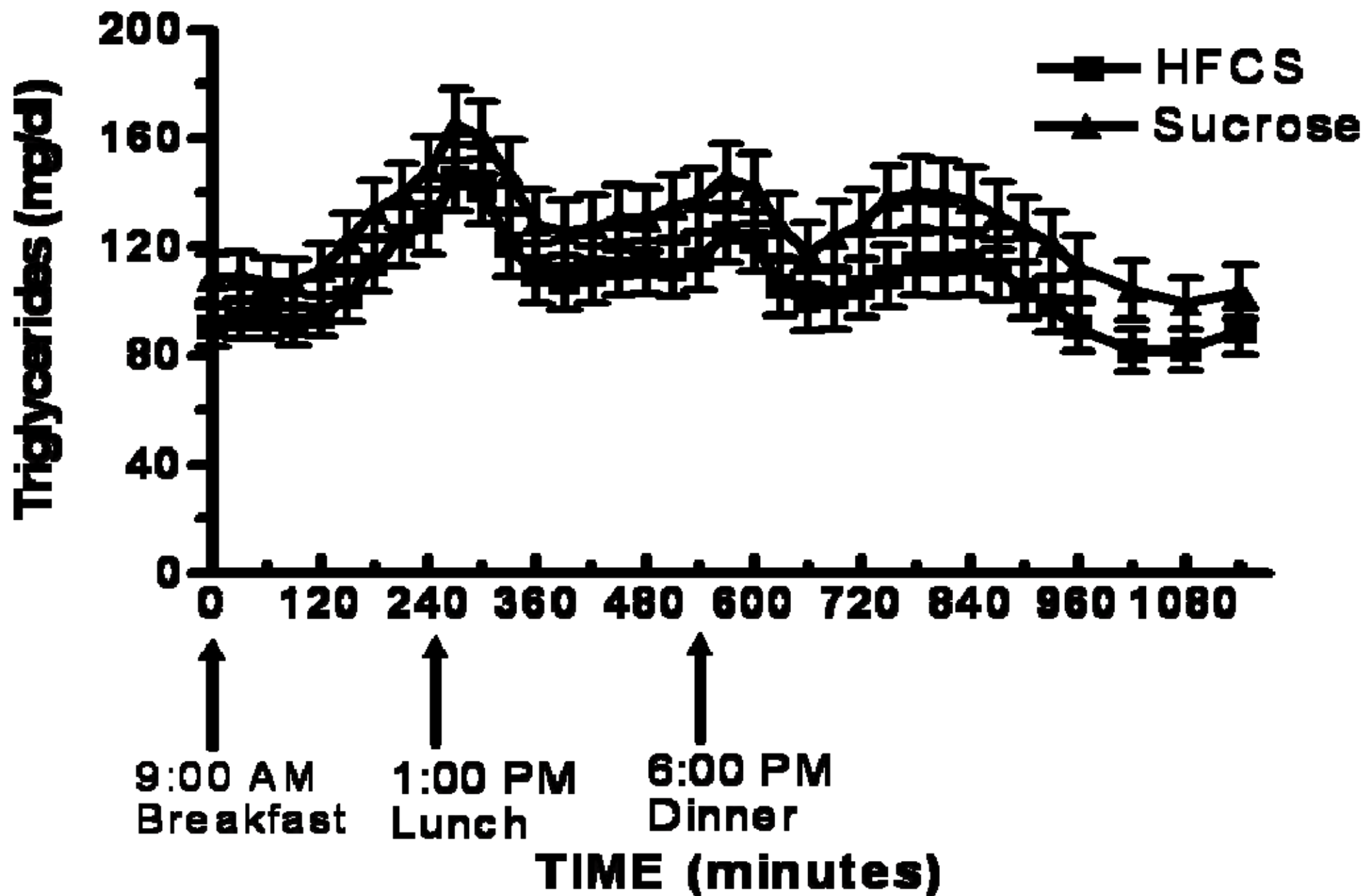
March 18, 2008

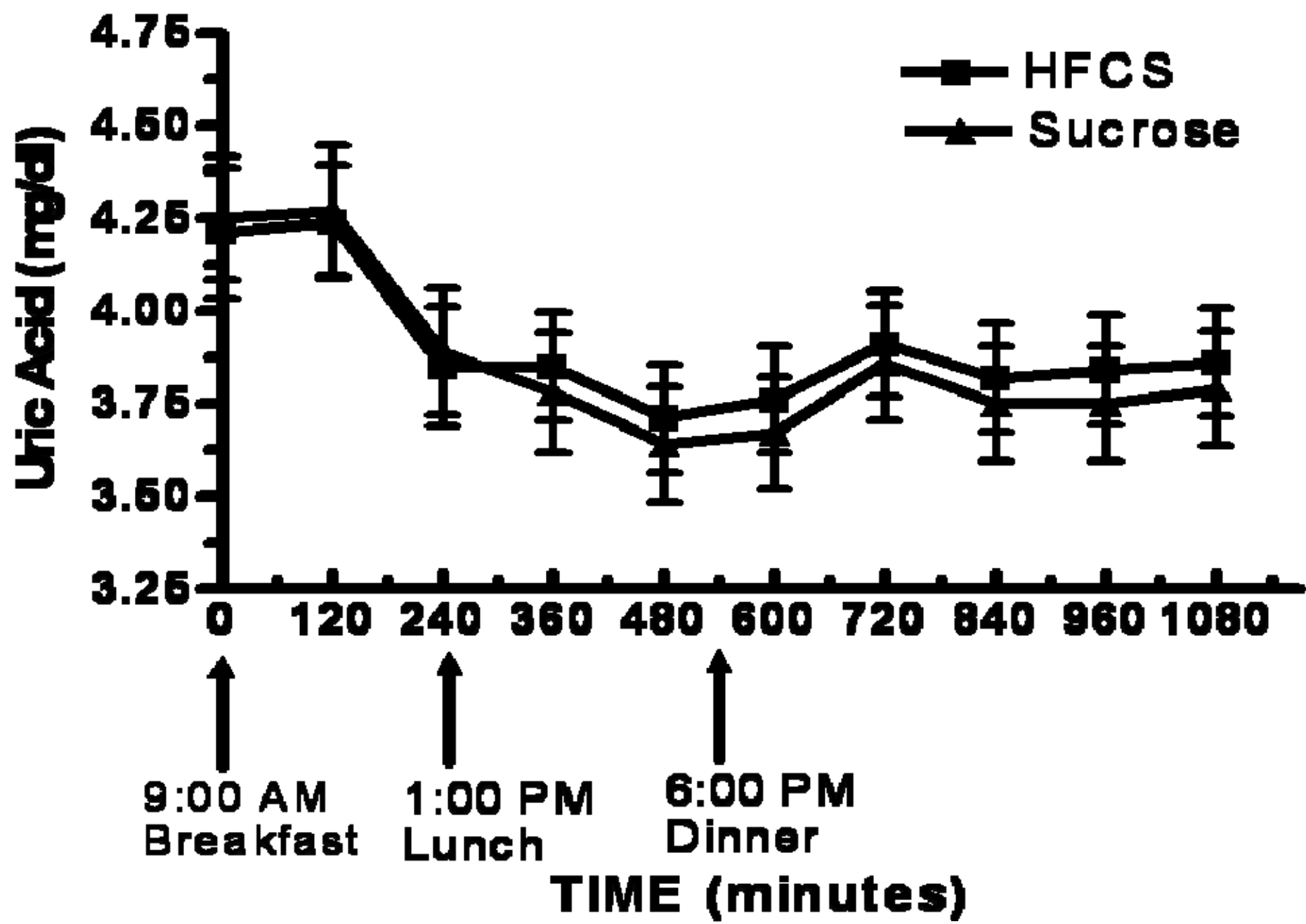
Purpose and Objectives

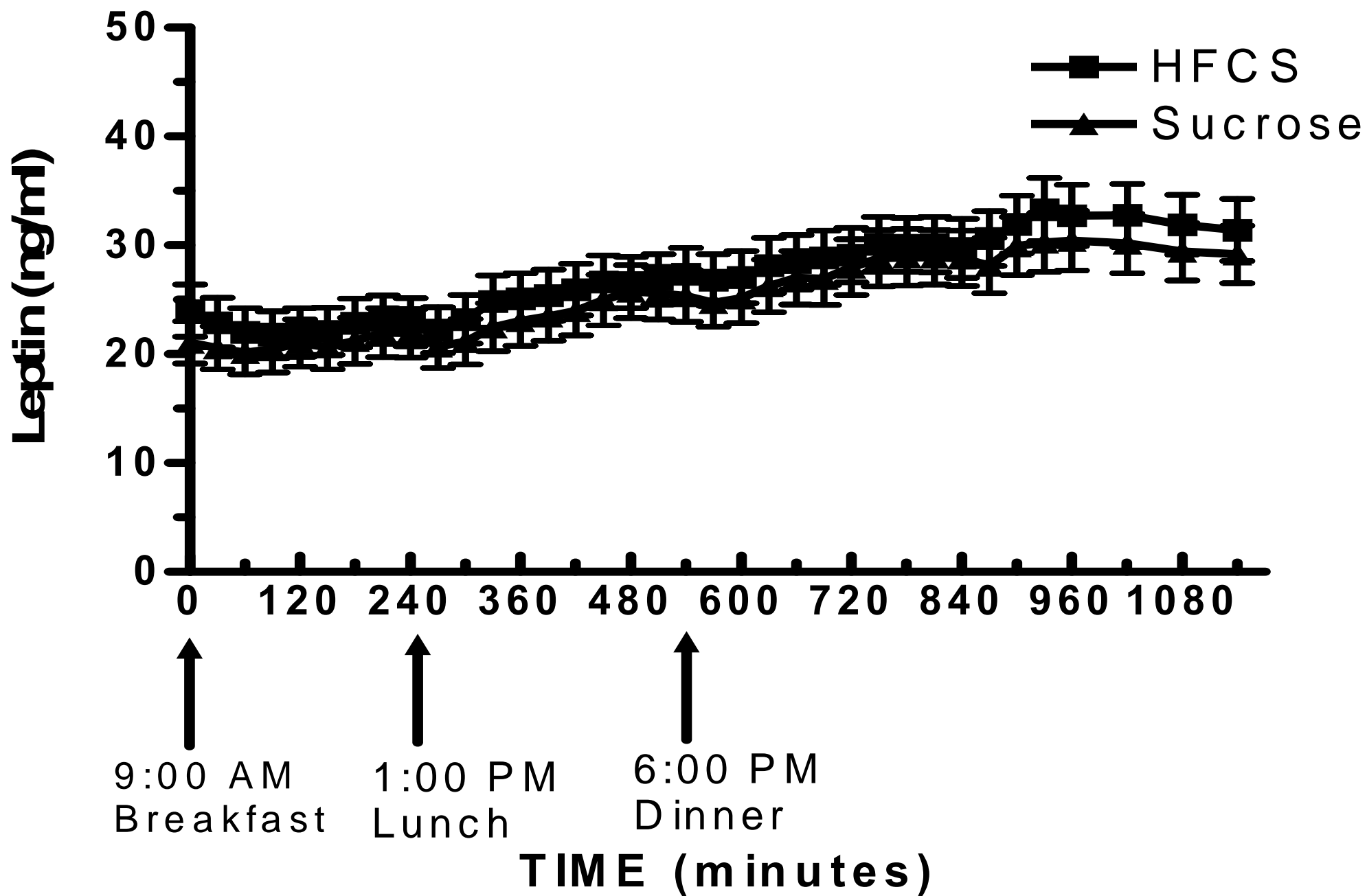
- The purpose of this study was to compare the effects of HFCS-55 (55% fructose) versus sucrose (50% fructose) on 24-hour circulating levels of hormones regulating body weight and appetite (insulin, leptin and ghrelin) and lipid levels (postprandial triglycerides and free fatty acids)
- The primary objective was to explore the impact of HFCS-55 or Suc when consumed as part of mixed meal, on postprandial triglycerides and uric acid levels in a controlled metabolic environment

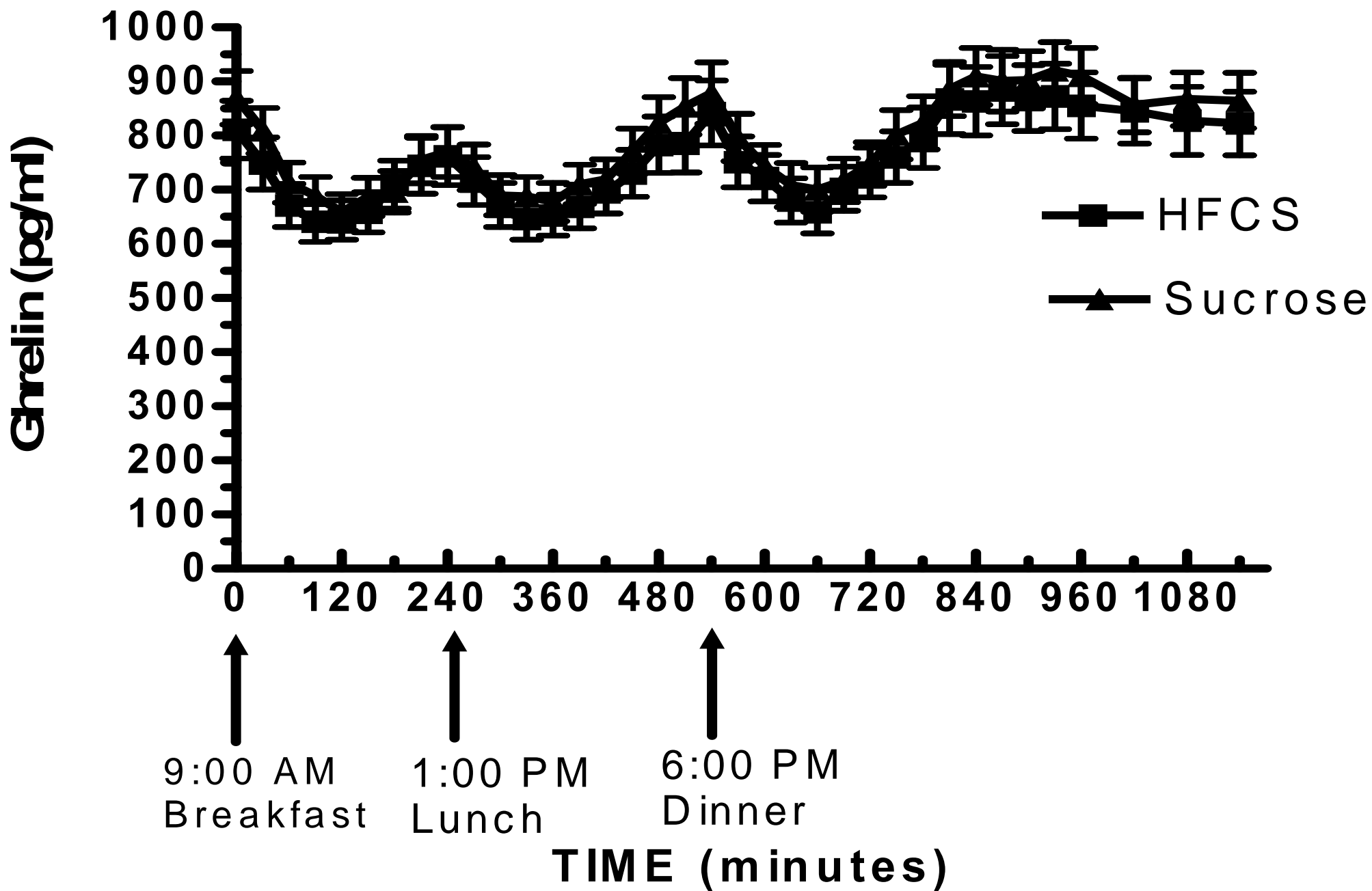












Net Area Under the Curve

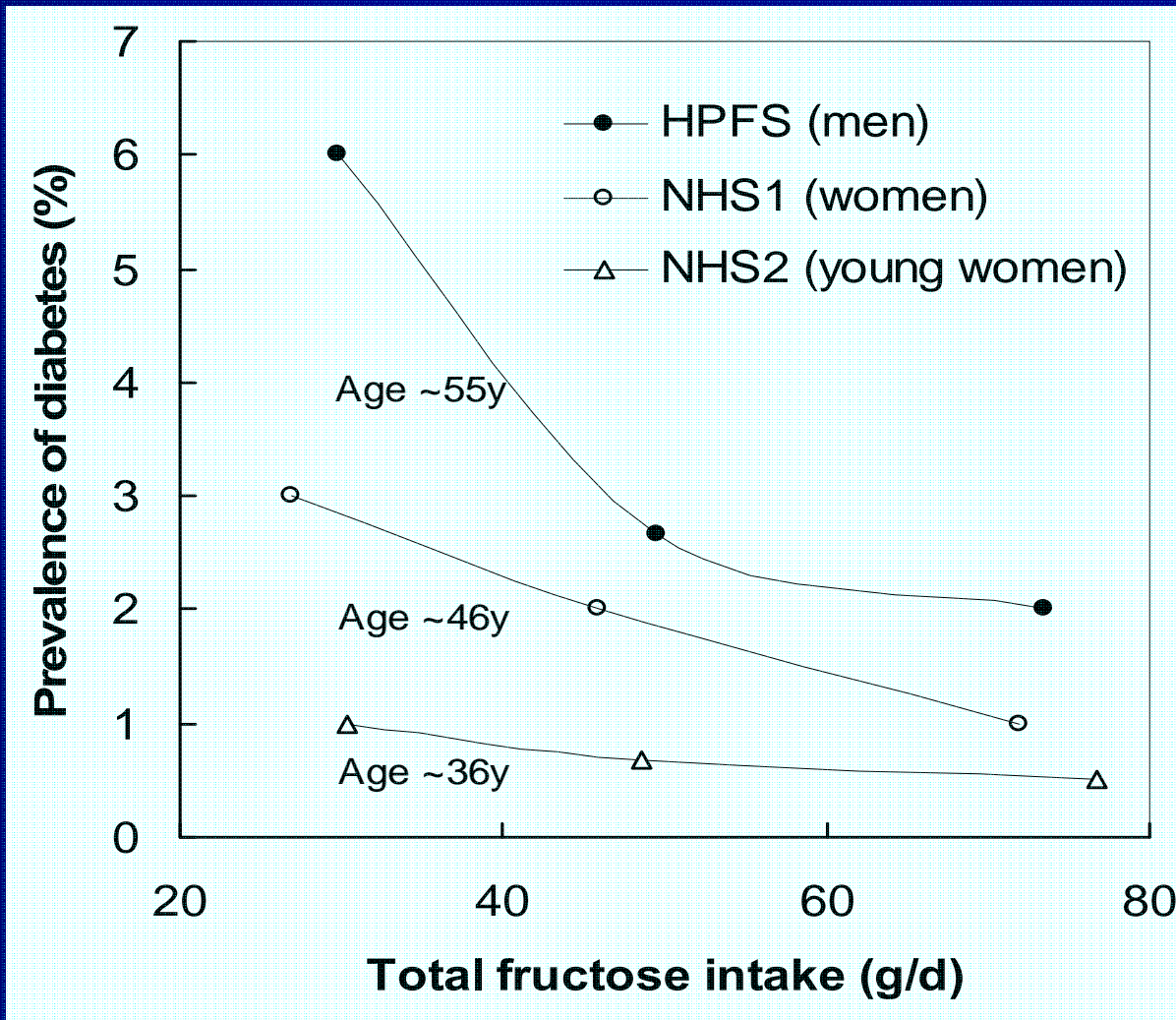
	HFCS	Sucrose	p
Glucose (mg/dl*22 h)	104.53 ± 195.96	77.14 ± 171.31	p>0.05
Insulin (μU/ml*22 h)	510.33 ± 321.43	460.27 ± 263.03	p>0.05
Triglycerides (mg/dl*22h)	304.92 ± 469.92	348.01 ± 524.79	p>0.05
Leptin (ng/ml*22h)	157.98 ± 91.75	153.20 ± 113.33	p>0.05

Conclusions

- **Both HFCS and sucrose consumption resulted in similar responses of glucose, insulin, leptin and ghrelin.**
- **These two sweeteners do not differ significantly in their glycemimic or insulinemic responses when consumed with foods, despite their slight difference in fructose content.**

Type 2 Diabetes

Cross-sectional data



Limitations:

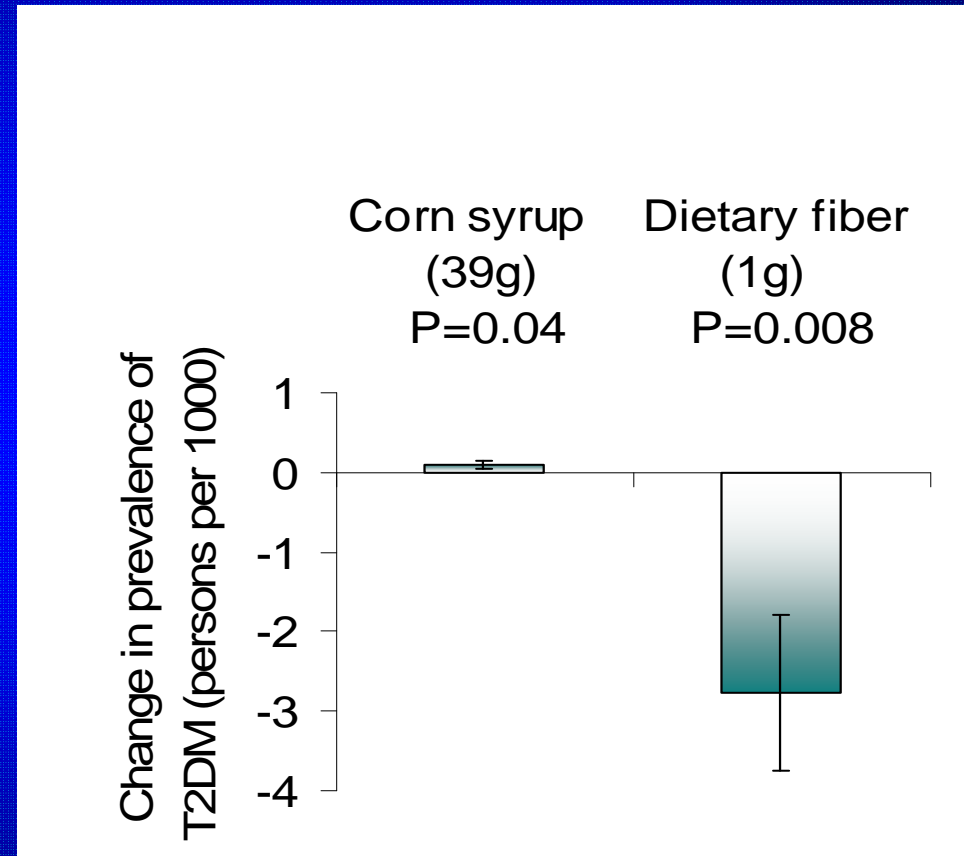
Diabetics eat less sugar or report they eat less sugar or less sugar contributes to diabetes or fructose may be protective or all of these.

Again, no suspicion that fructose causes type-2 diabetes

Ecological data: type-2 diabetes and fructose intake

Gross et al, AJCN 2004;79:774-9

Dietary fibre appears 1000 x more preventative than 'high fructose corn syrup' is promotive of type 2 diabetes



Dietary fibre more than HFCS associates with type-2 diabetes

Conclusions

Conclusions

- **Fructose is a naturally occurring sugar with a pleasant taste.**
- **Fructose produces a smaller postprandial rise in plasma glucose than other carbohydrates.**
- **Fructose appears to have adverse effects on plasma lipids, particularly triglycerides.**

Conclusions (cont.)

- **Adding large amounts of free fructose to the diet may be undesirable.**
- **Both HFCS and sucrose consumption resulted in similar glycemic and endocrine responses**

Dietary Guidance

- **Telling consumers to eat less fructose is not practical**
- **Focus on added sugars messages from Dietary Guidelines for Americans**

“To lengthen thy life, lessen thy meals”

Benjamin Franklin 1733

“and quicken thy heart with exercise”

Questions