Health & Nutrition Committee

Scientific Advisory Board Meeting

January 30, 2013 – Seattle, WA

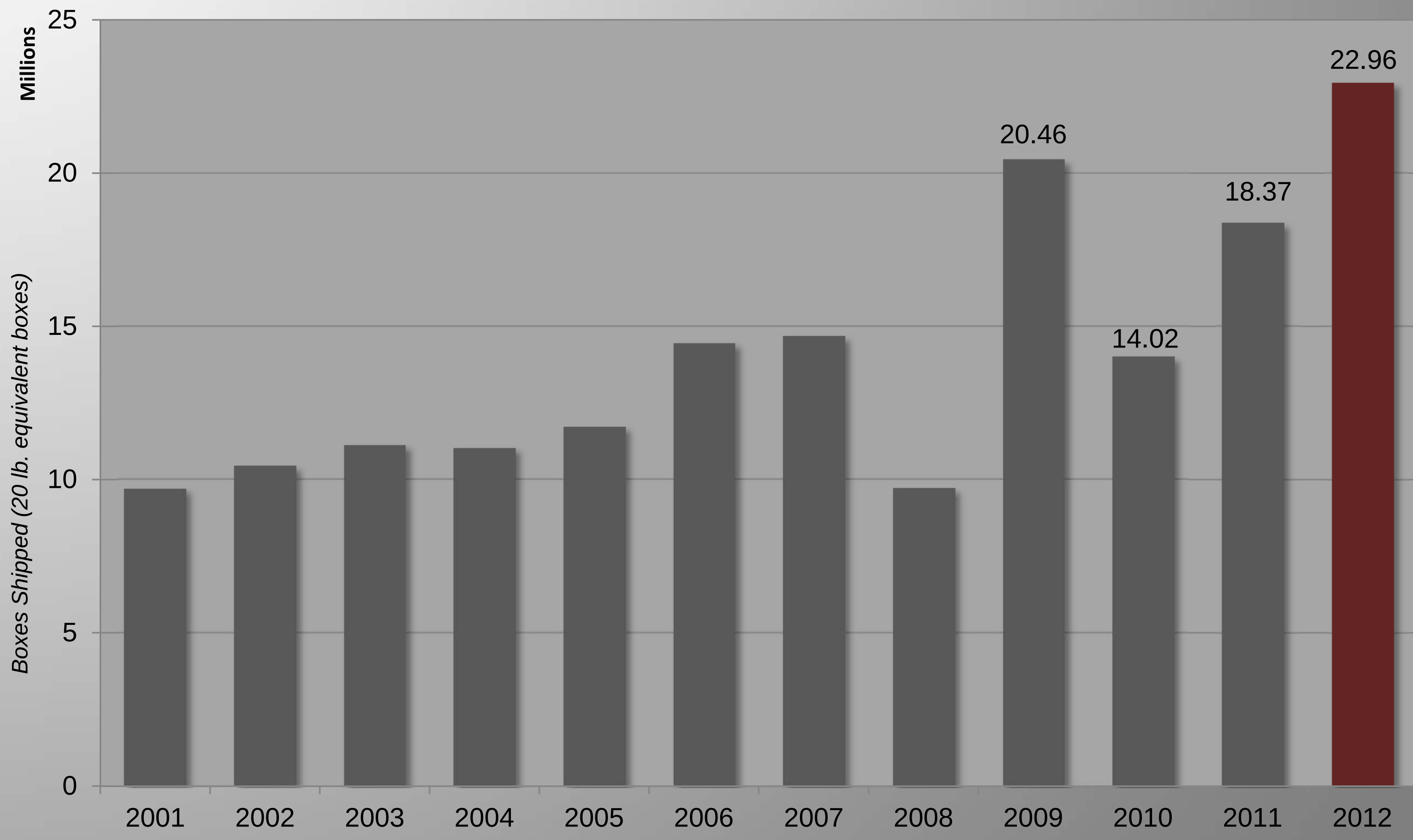
Pacific Coast Cherry Industry

Health Science Advisory Board Meeting

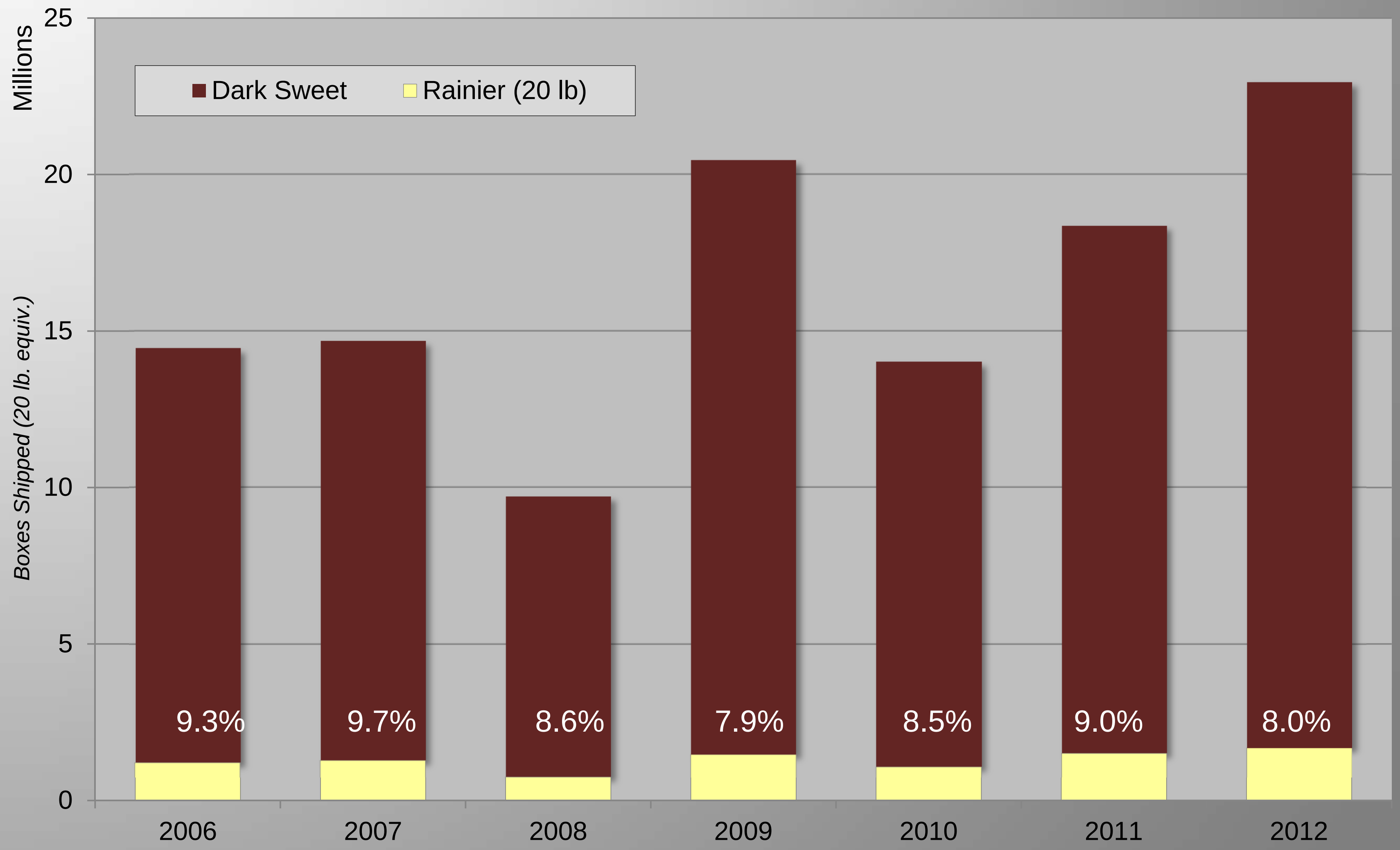
January 30, 2013

Sweet Health

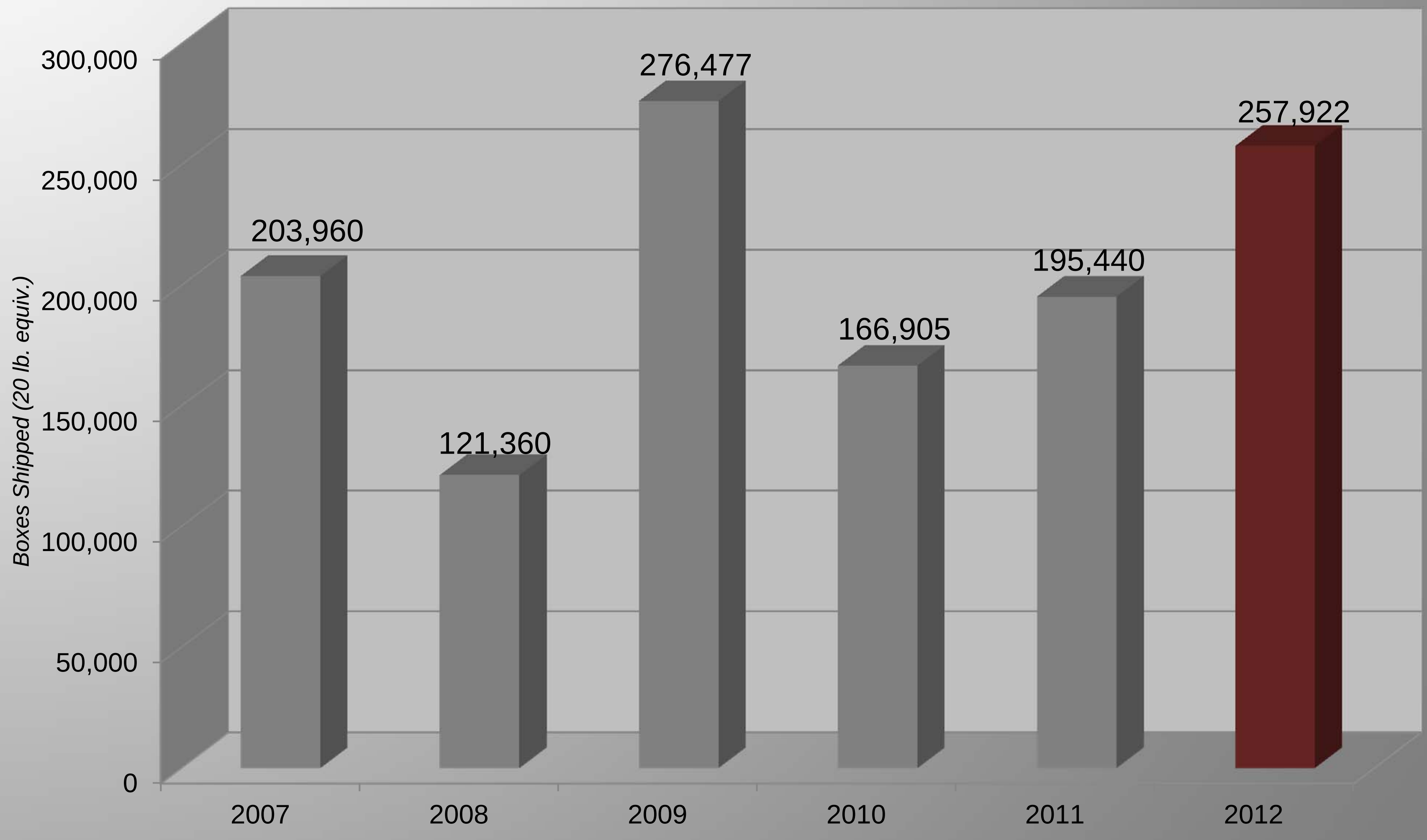
NW Total Season Shipments



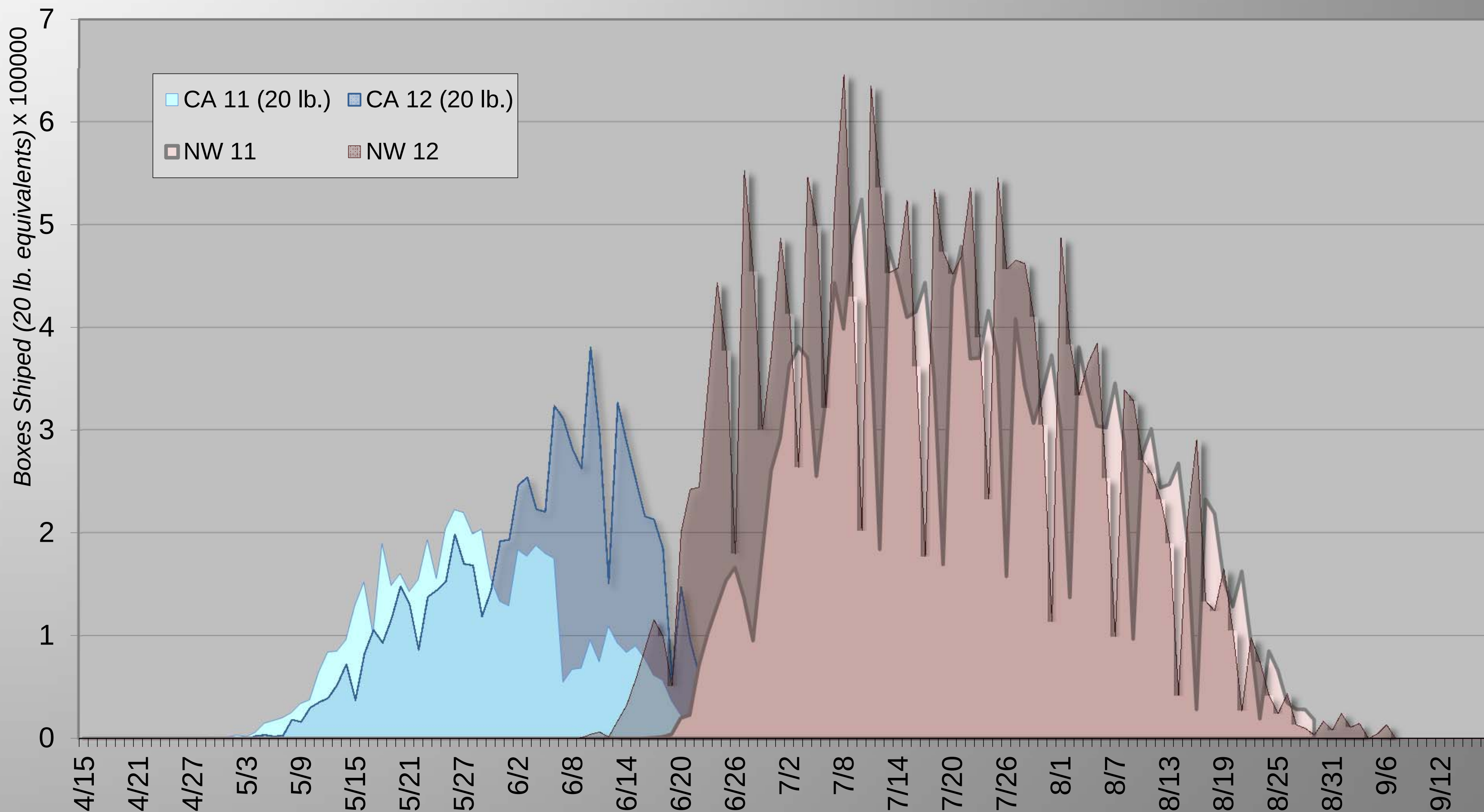
Red & Rainier Shipments



Average Daily Shipments

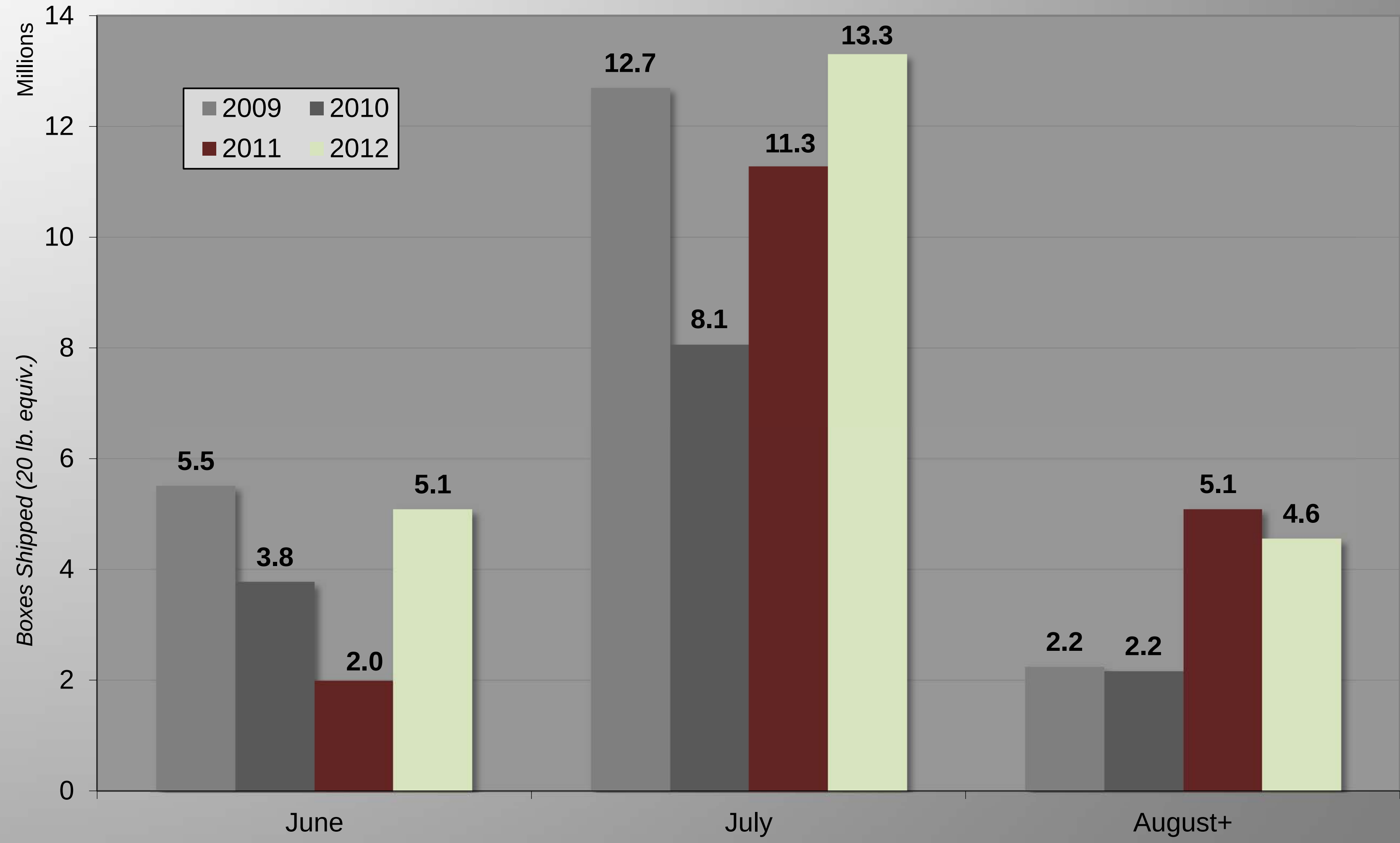


Pacific Coast Cherry Shipments YOY

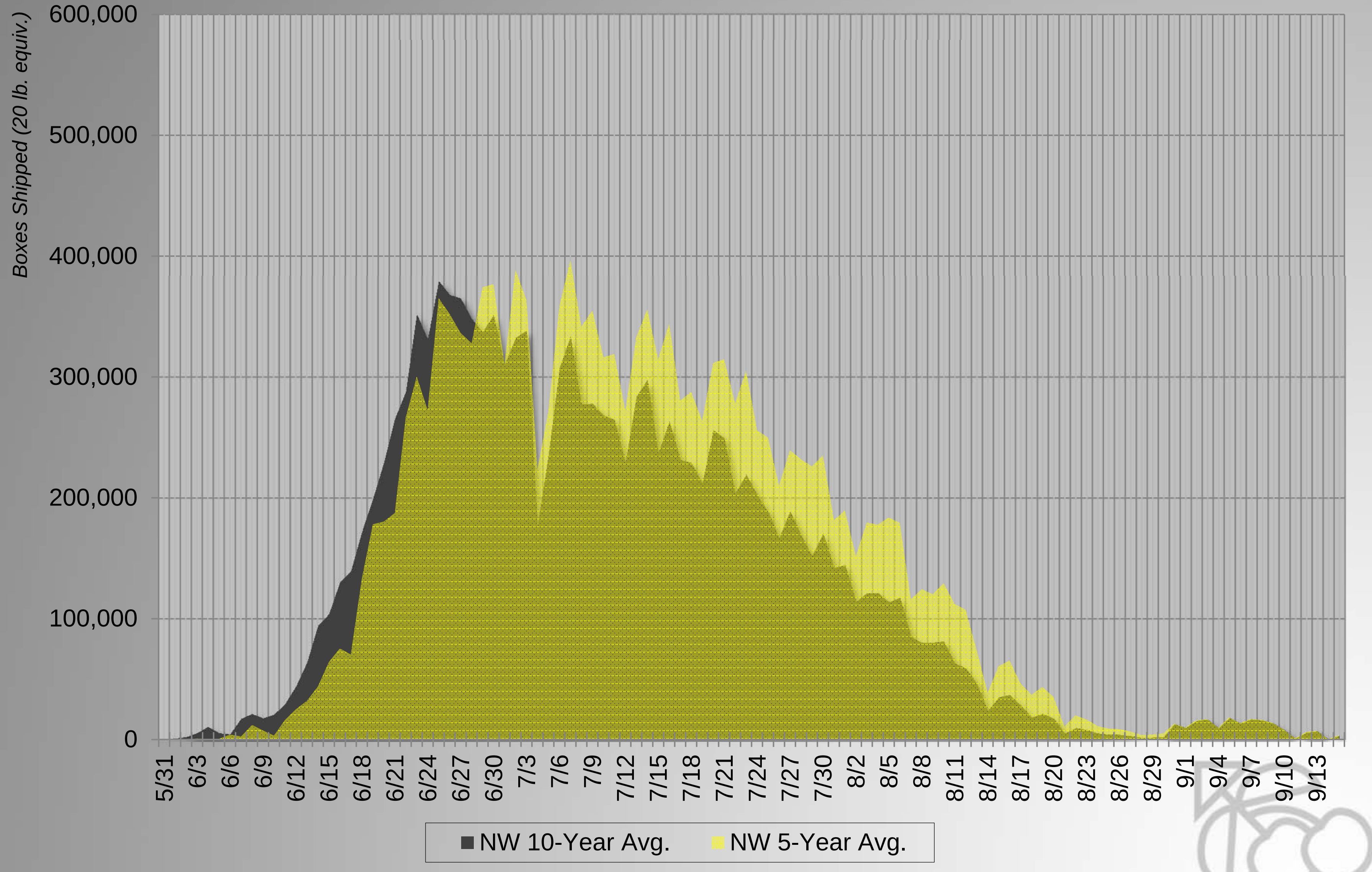


Western US Sweet Cherry
Shipments
The Pacific Coast Industry
Is Now at over 100,000 Acres
in the ground
Millions
(20 lb. equiv.)
35
30
25
20
NW
CA
23.0
18.4
7.4
7.8
5.4
7.7
2008
2009
2010
2011
2012

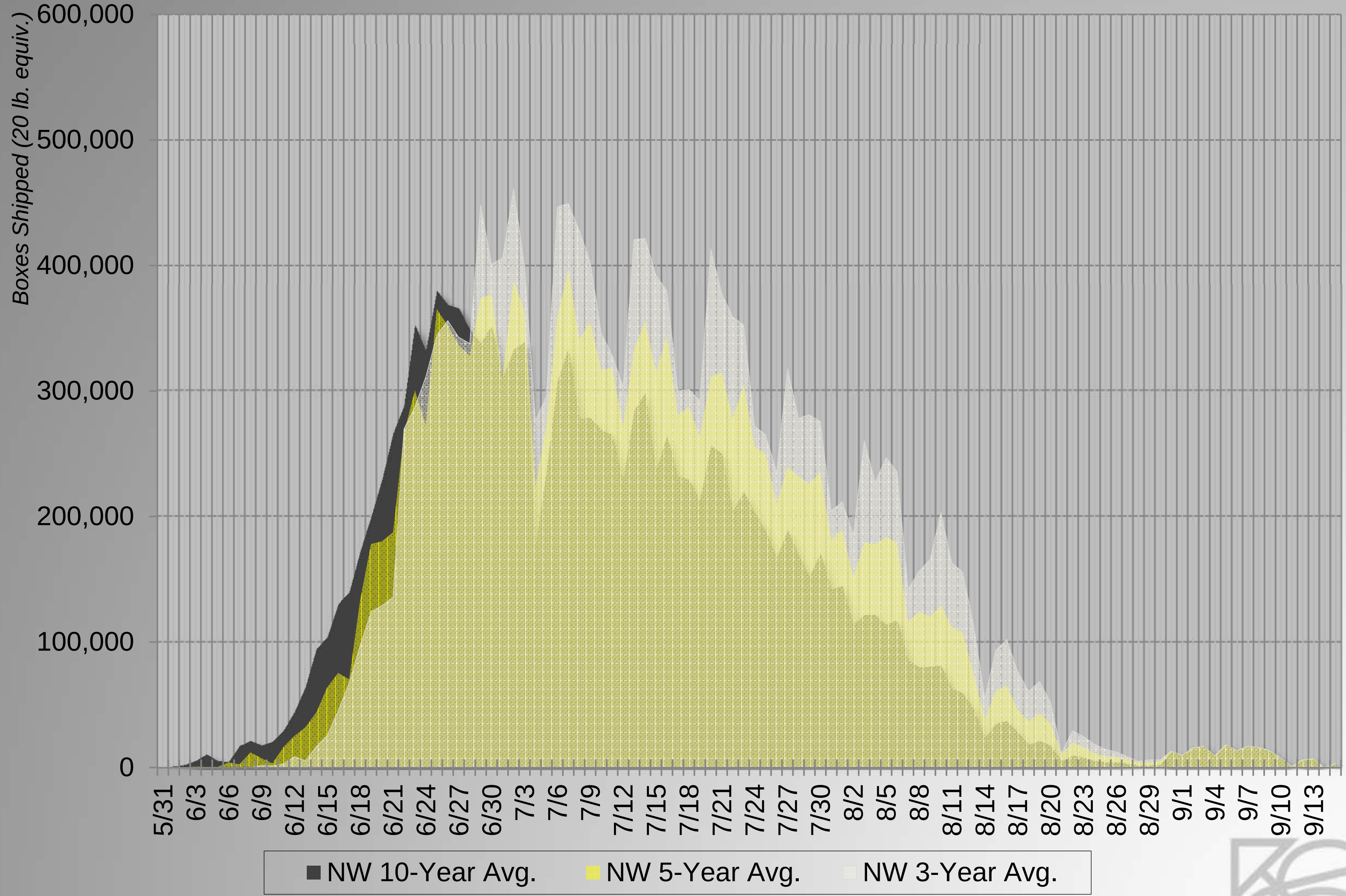
Monthly Shipments



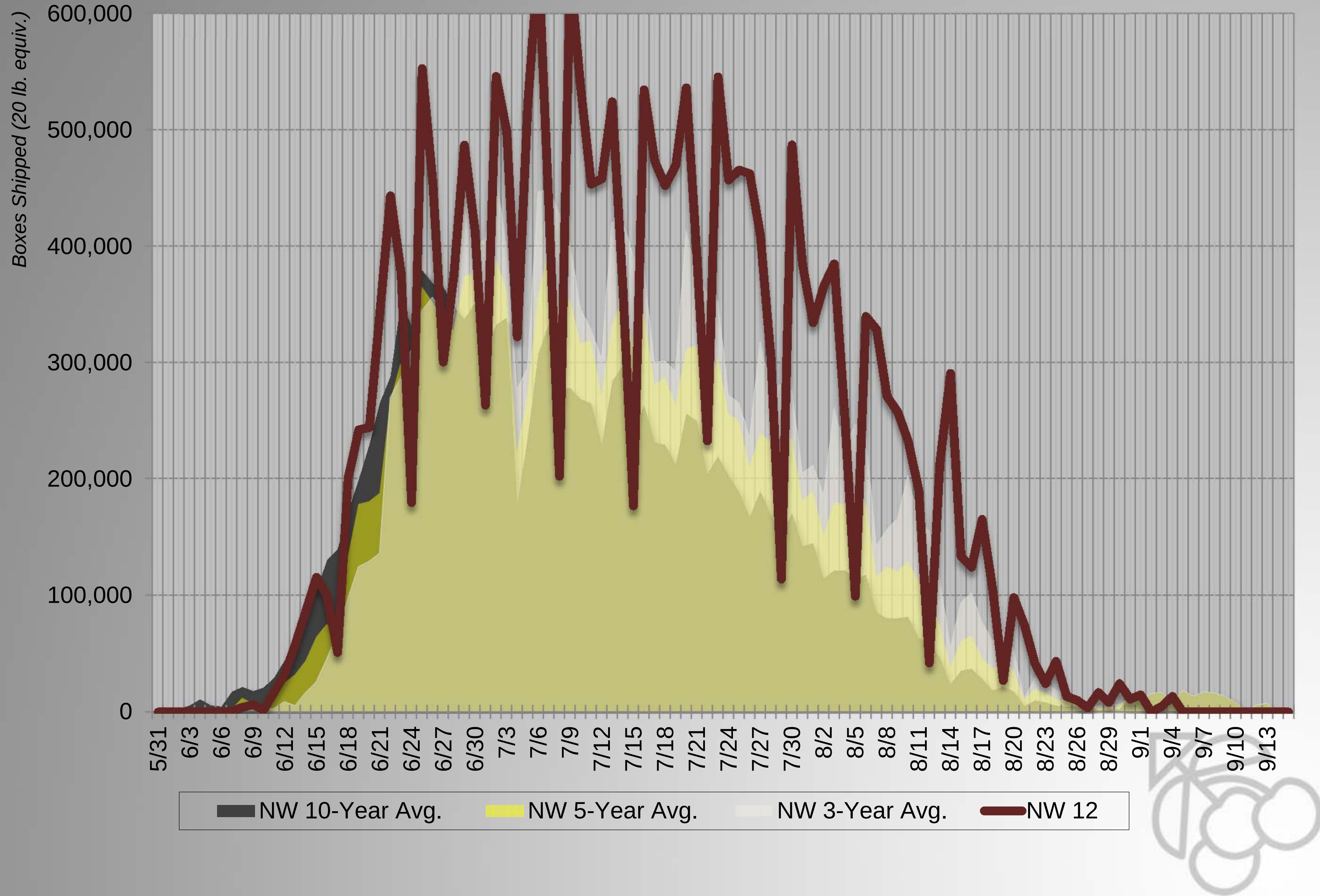
5-Year Average



3-Year Average



2012 Daily Shipment Curve



A Challenging Crop of Record Volume Did Have Some Positive Results For the Future ….

- Record Advertising Activity in Domestic and Foreign Markets.
- Export Markets Saw A 43% increase up from 5.7 million boxes in 2011 to 8 million boxes in 2012
- The Record Rainier Crop saw strong demand and repeat consumer purchases from start to finish
- 2012 vs. 2009 … 2 million more boxes this year

Health & Nutrition Research

- **Industry meeting in January 2008**
- **Joint Health & Nutrition Committee (HNC) formed**
  - *What do we know about cherry health benefits?*
  - *Where are the holes in the research?*
  - *What do consumers care about?*
  - *Which research initiatives should industry pursue?*
  - *How much does it cost and how does it get funded?*
- **Formation of Scientific Advisory Board (SAB)**

Health & Nutrition Research

- **Formation of Scientific Advisory Board (SAB)**
  - *- Andrew Bresksa, Research Chemist, USDA, ARS, WRRC*
  - *- Darshan Kelley, Research Chemist, USDA, ARS, WHNRC, UC Davis*
  - *- Cynthia Thomson, Associate Professor, Nutritional Sciences and Medicine, University of Arizona*
- **First meeting March 2, 2009 in Seattle**
- **Second meeting March 2, 2010 in Lodi, CA**

Key Recommendations

- **Prioritized based on need to build a foundation for understanding**
- **Cost sharing between California and Northwest**

		Cost (Est.)
✓	1. Rules Based Medicine Study	*$115,500*
✓	2. Develop a Standardized Product to Aid Future Research	*$8,500*
✓	3. Develop a Placebo to Match the Standard Product	*$35K*
	4. Chemical Analysis of the Fruit	*$20-30K +*
	5. Dose Response Study	*$60-80K +*
✓	6. Feeding Trials	*roughly $100K*
	7. Gene Array Sample	*$20-40K +*
	8. Epidemiological Study – Retro Data Analysis	*$50K+*
	9. Clinical Studies	*significant*

Sweet Health

POWDERPURE

For this trial we will:

(1) run three formulations of equal size for optimization of flowability/flavor/color/nutrient retention (with the objective to minimize carrier content as much as possible); each formulation will yield approximately 60 lbs of powder.
(2) test solid content of raw material to provide commercial yield analysis;
(3) provide accurate price estimate for commercial toll processing of the product;
(4) Antioxidant testing of raw material and finished powder (all formulations);
(5) provide powder samples - each formulation will yield approximately 60lbs of powder; and
(6) samples will be packaged in 280 gram packs (equivalent weight to 45 pitted cherries): this will supply approximately 289 separate 280 gram packets - or 96 packets of each formulation.

- **Discussion**

- Formulation?

- Amount of finished product is small? More fruit needed?

Effects of Bing Sweet Cherries on Markers of Human Health

Darshan S. Kelley, PhD

Yuriko Adkins, PhD

Western Human Nutrition Research Center, ARS, USDA and Department of Nutrition, University of California, Davis

December 14, 2011, Suncadia Lodge, Cle Elum, WA

Background 1

- Inflammation is a local healing response to microbial invasion or injury; blood cells & mediators
- Chronic inflammation leads to a number of human diseases including diabetes, arthritis, CVD. Blood cholesterol normal in 50% of those getting fatal heart attack, have increased inflammation
- Markers for inflammation include, CRP, SAA, inflammatory cytokines & eicosanoids & others

Background 2

- Cherry feeding claimed to reduce arthritis in humans:
  - Ludwig W. Blau (1950) – consumption of ~227 g fresh or canned cherries per day alleviated gouty arthritis
  - Jacob, R.A. et al. (2003) – consumption of cherries reduced the serum concentration of uric acid and markers of inflammation (CRP and NO) in healthy young women

Blau LW., Cherry diet control for gout and arthritis. Texas Rep Biol Med. 1950; 8:309-311.
Jacob R. et al. Consumption of cherries lowers plasma urate in healthy women. J Nutr. 2003; 133:1826-1829.

Acute Effects of Cherries on Plasma Biomarkers

Jacob R. et al. Consumption of cherries lowers plasma urate in healthy women. J Nutr. ***2003****; 133:1826-1829*

Biomarker	Baseline	5 h
Urate (μmol/L)	214 ± 13	183 ± 15*
CRP (mg/L)	4.29 ± 2.18	3.59 ± 1.59
Nitric Oxide (μmol/L)	37.4 ± 5.2	31.6 ± 2.1

*Different from baseline, *P*<0.05

2003 WHNRC Cherry Study

Specific Aims

Determine the effects of cherry consumption on:

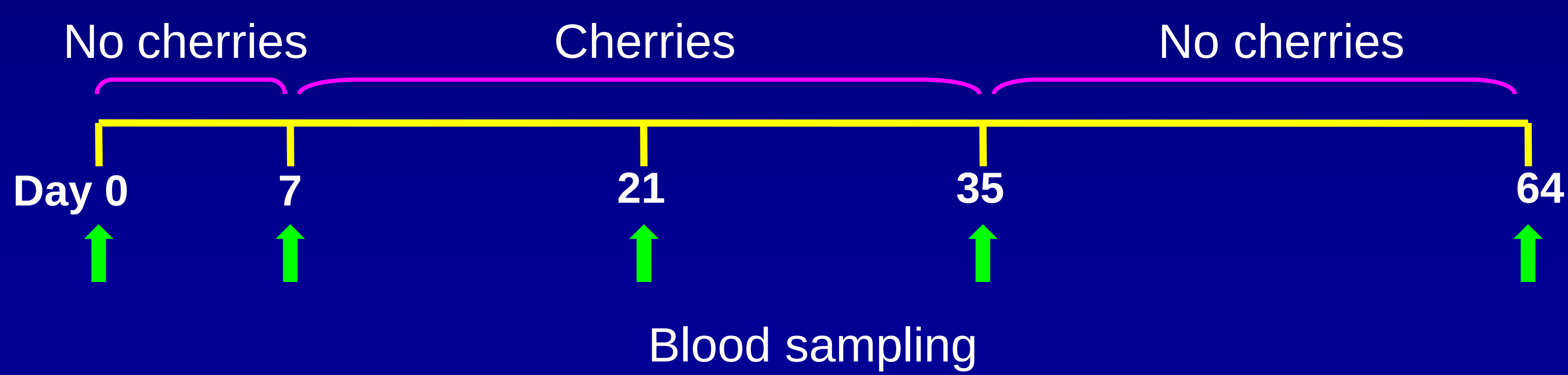
1. Serum concentration of markers of inflammation
2. Blood lipids, lipoproteins, particle size & number;
3. Hematology & clinical chemistry panels including insulin

Subject Characteristics and Study Design

2 men, 18 women

Variable	Min	Max	Mean	SEM
Age (yrs)	45	61	50	0.9
Weight (kg)	53.6	113.0	73.3	3.6
Height (cm)	150.5	186.0	166.3	2.2
BMI	19.6	30.4	26.3	0.9

Intervention: 280 g cherries (~45 cherries)



THE JOURNAL OF NUTRITION

Consumption of Bing Sweet Cherries Lowers Circulating Concentrations of Inflammation Markers in Healthy Men and Women[1,2]

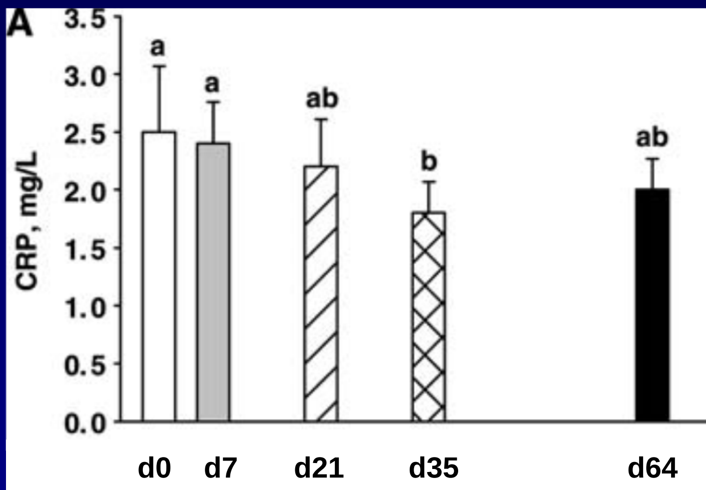
Darshan S. Kelley,*[3] Reuven Rasooly,* Robert A. Jacob,* Adel A. Kader,† and Bruce E. Mackey**

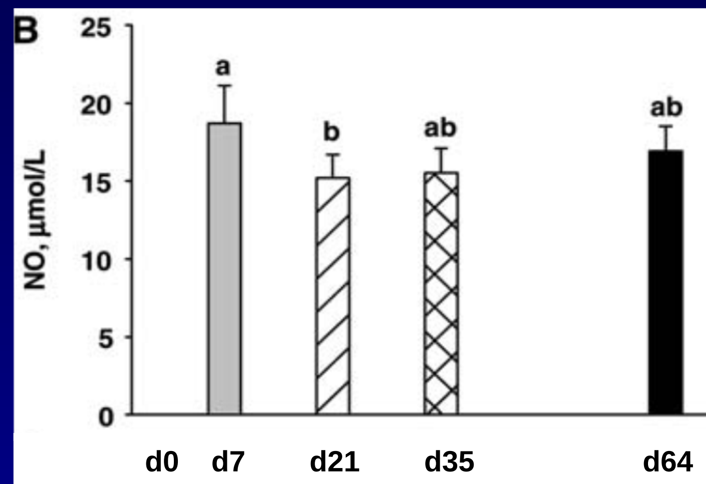
*U.S. Department of Agriculture/ARS, Western Human Nutrition Research Center, and Department of Nutrition, University of California, Davis, CA 95616; †Department of Plant Sciences, University of California, Davis, CA 95616; and **Western Regional Research Center, ARS, U.S. Department of Agriculture, Albany, CA 94710

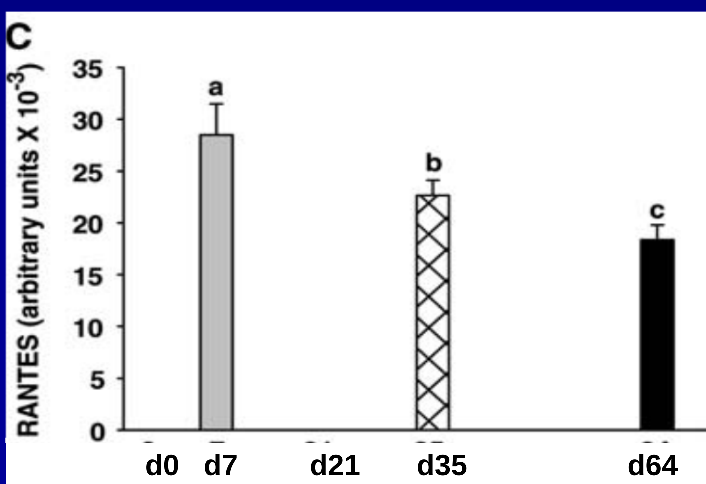
J. Nutr. 2006; 136:981-986

Effect Of Cherry Consumption On Circulating Markers Of Inflammation

Kelley et al. J Nut. 2006; 136:981-986



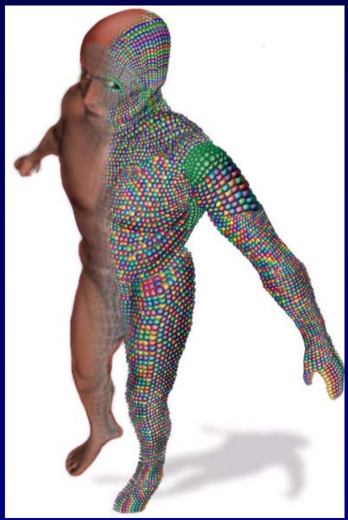




<u>No changes in:</u>

- IL-6
- ICAM-1
- TIMP-2
- Glucose
- Insulin
- Blood lipids
- Lipoprotein size and numbers
- Haematological and chemistry panels

RBM
RULES • BASED MEDICINE



HumanMAP version 1.6

The Human MAP measures 89 antigens using less than 100 µL of plasma

1. Adiponectin
2. Alpha-1 Antitrypsin
3. Alpha-Fetoprotein
4. Alpha-2 Macroglobulin
5. Apolipoprotein A-1
6. Apolipoprotein C-III
7. Apolipoprotein H
8. Beta-2 Microglobulin
9. BDNF
10. C-Reactive Protein
11. Calcitonin
12. Cancer Antigen 19-9
13. Cancer Antigen 125
14. Carcinoembryonic Antigen
15. CD40
16. CD40 Ligand
17. Complement 3
18. CK-MB
19. Endothelin-1
20. Eotaxin
21. Epidermal Growth Factor
22. ENA-78
23. Erythropoietin
24. ENRAGE
25. Factor VII
26. Fatty Acid Binding Protein
27. Ferritin
28. Fibrinogen
29. FGF-basic
30. GST
31. G-CSF
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34. Haptoglobin
35. Immunoglobulin A
36. Immunoglobulin E
37. Immunoglobulin M
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57. Interleukin-16
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59. Lipoprotein (a)
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61. MDC
62. MIP-1 alpha
63. MIP-1 beta
64. MMP-2
65. MMP-3
66. MMP-9
67. MCP-1
68. Myeloperoxidase
69. Myoglobin
70. PAI-1
71. PAPP-A
72. PSA, Free
73. Prostatic Acid Phosphatase
74. RANTES
75. Serum Amyloid P
76. SGOT
77. Sex Hormone Binding Globulin
78. Stem Cell Factor
79. Thrombopoietin
80. Thyroxine Binding Globulin
81. Thyroid Stimulating Hormone
82. Tissue Factor
83. TIMP-1
84. Tumor Necrosis Factor-alpha
85. Tumor Necrosis Factor-beta
86. Tumor Necrosis Factor RII
87. VCAM-1
88. VEGF
89. von Willebrand Factor

JN THE JOURNAL OF NUTRITION

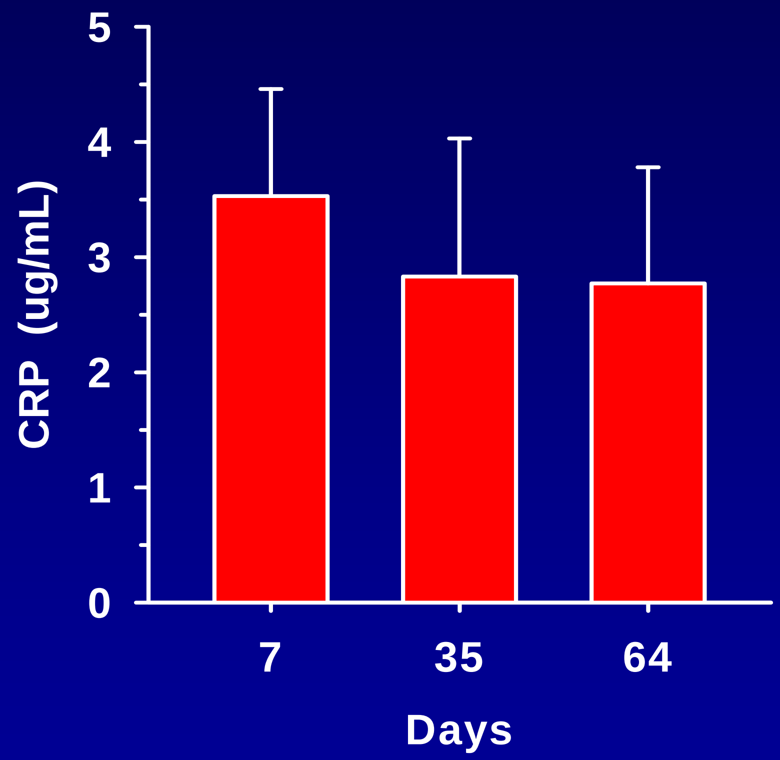
Sweet Bing Cherries Lower Circulating Concentrations of Markers for Chronic Inflammatory Diseases in Healthy Humans[1-4]

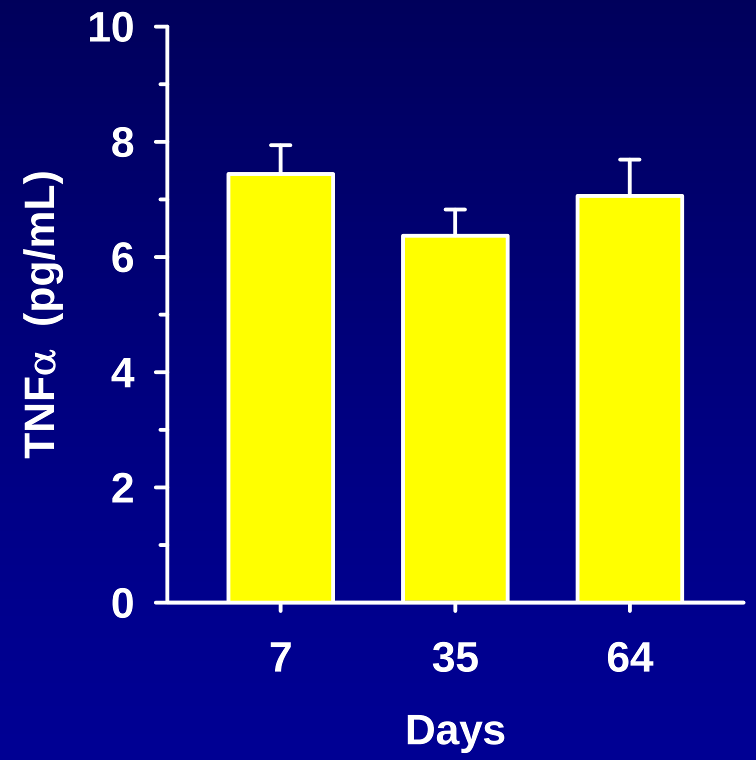
Darshan S. Kelley[5]*, Yuriko Adkins[5], Aurosis Reddy[5], Leslie R. Woodhouse[5], Bruce Mackey[6], and Kent L. Erickson[7]

[5]Western Human Nutrition Research Center, Agricultural Research Service, USDA, and Department of Nutrition, University of California, Davis, CA; [6]Western Regional Research Center, Agricultural Research Service, USDA, Albany, CA; and [7]Department of Cell Biology and Human Anatomy, School of Medicine, University of California, Davis, CA

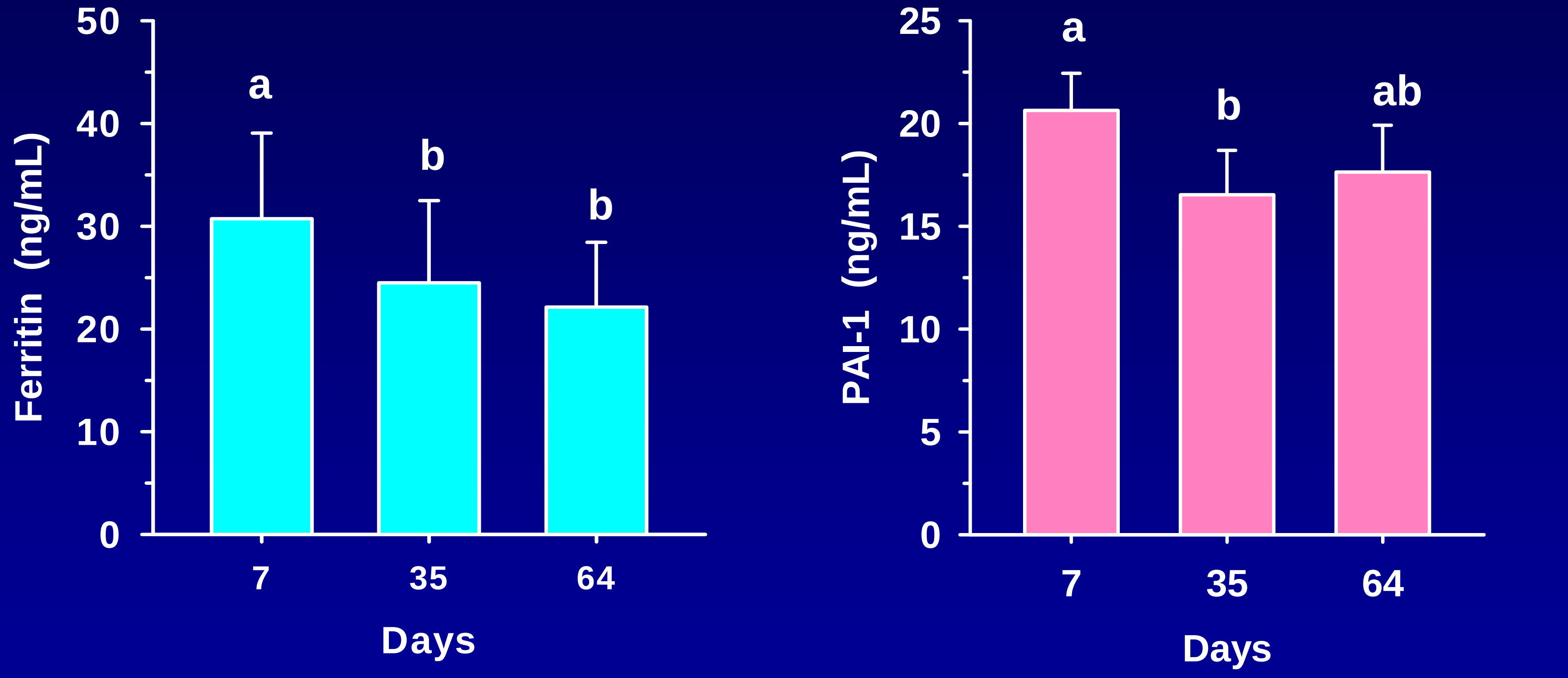
J. Nutr. 2013 (vol. 143)

Effects of Bing Sweet Cherry Consumption on CRP and TNFα

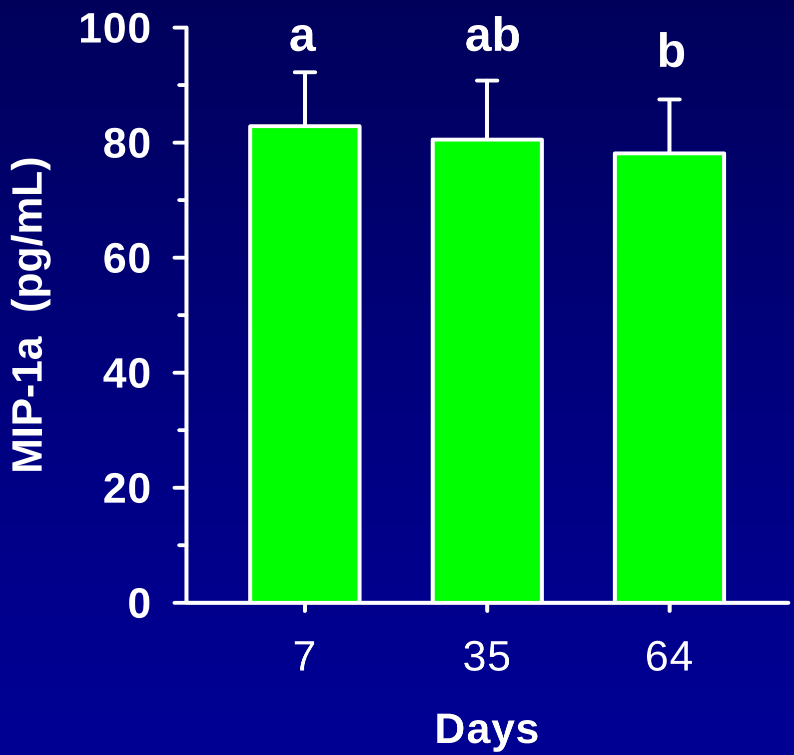


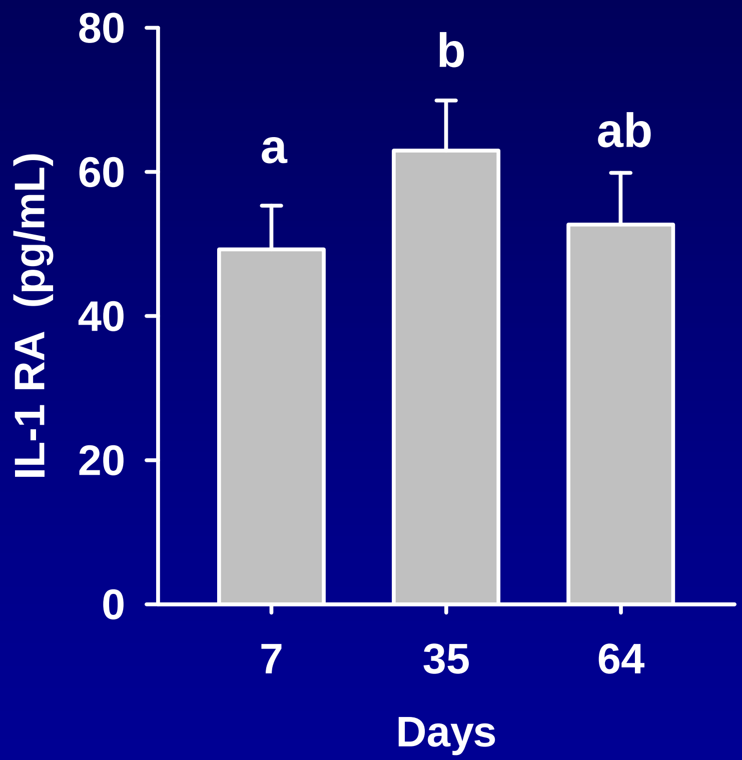


Effects of Bing Sweet Cherry Consumption on Ferritin and PAI-1

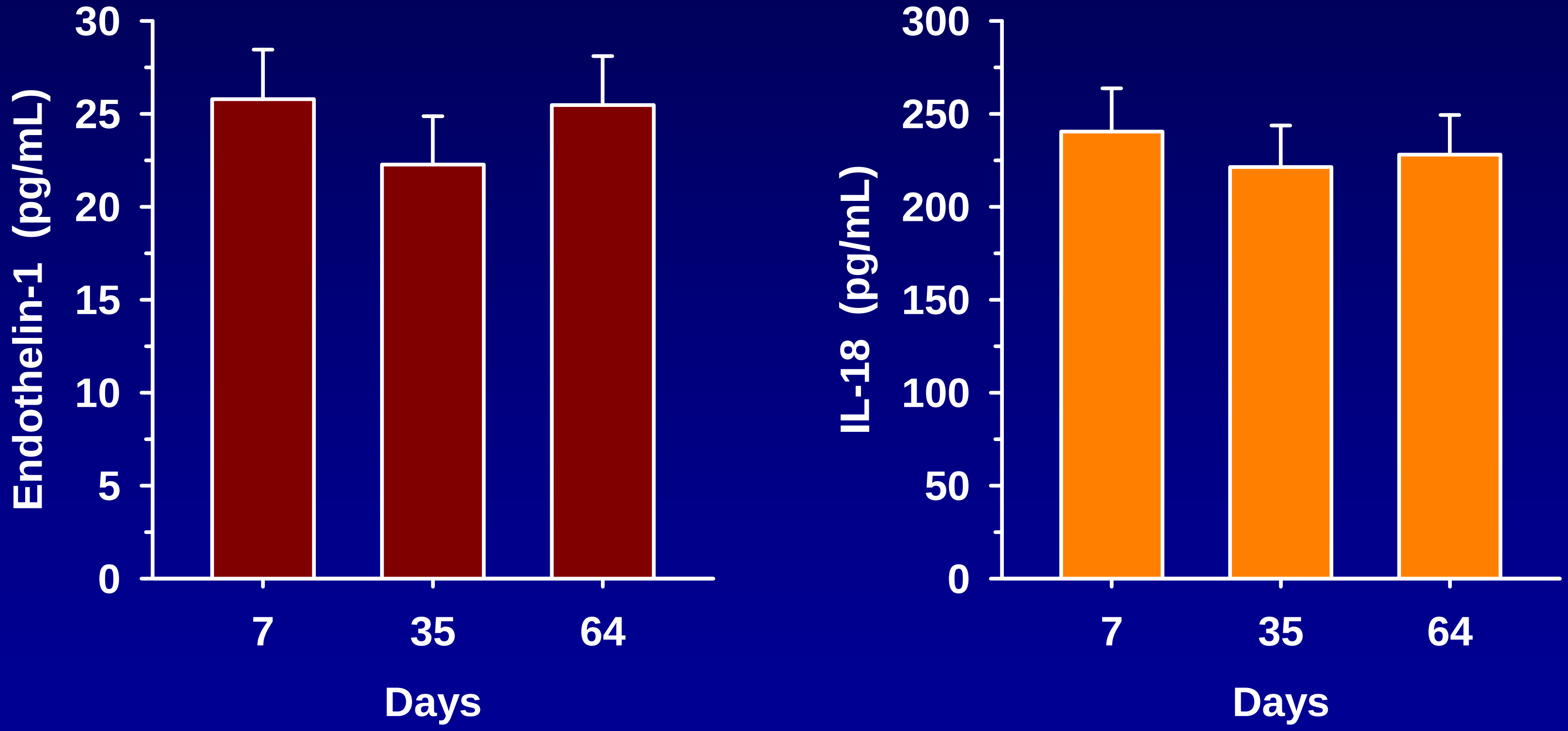


Effects of Bing Sweet Cherry Consumption on MIP-1a and IL-1RA

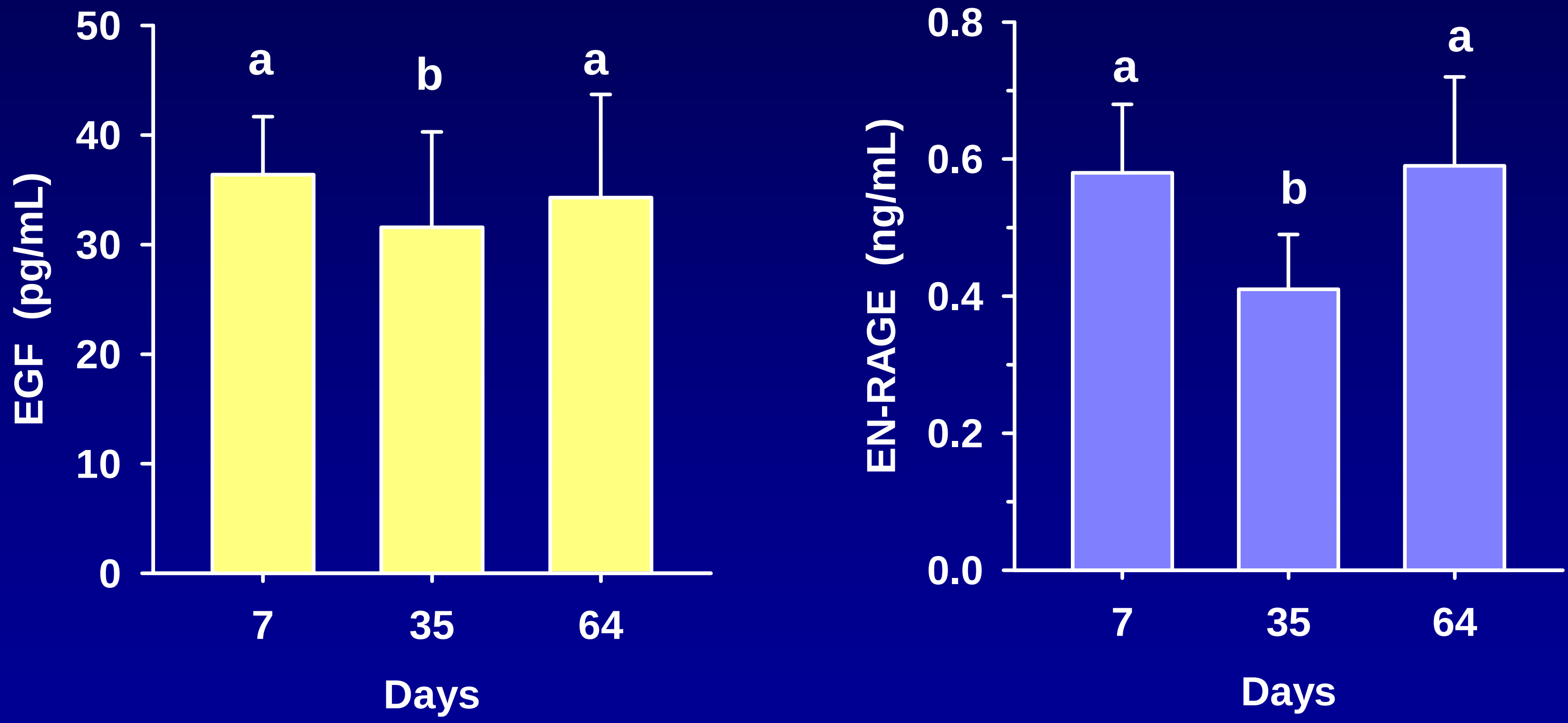




Effects of Bing Sweet Cherry Consumption on Endothelin-1 and IL-18



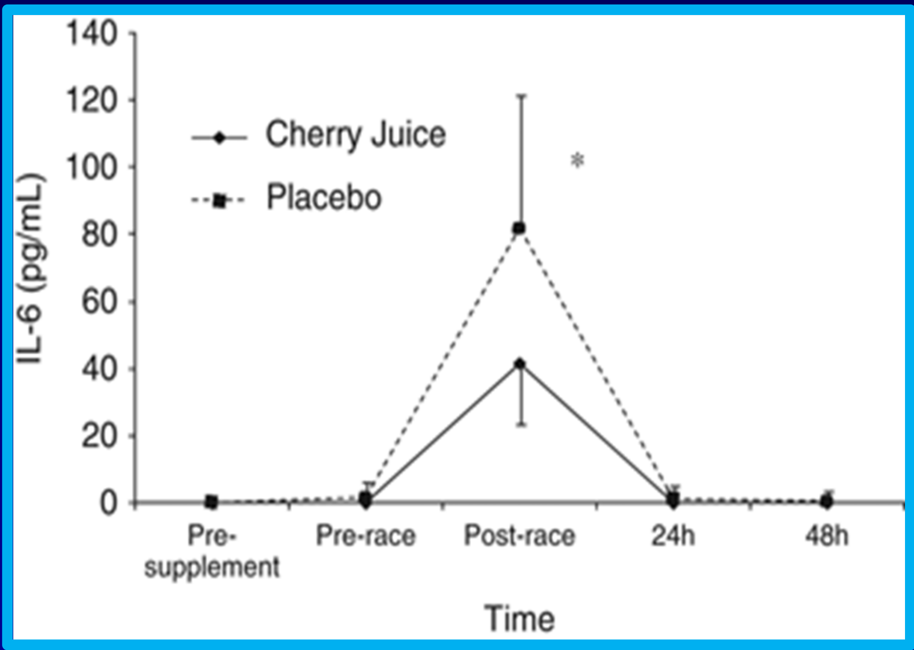
Effects of Bing Sweet Cherry Consumption on EGF and EN-RAGE

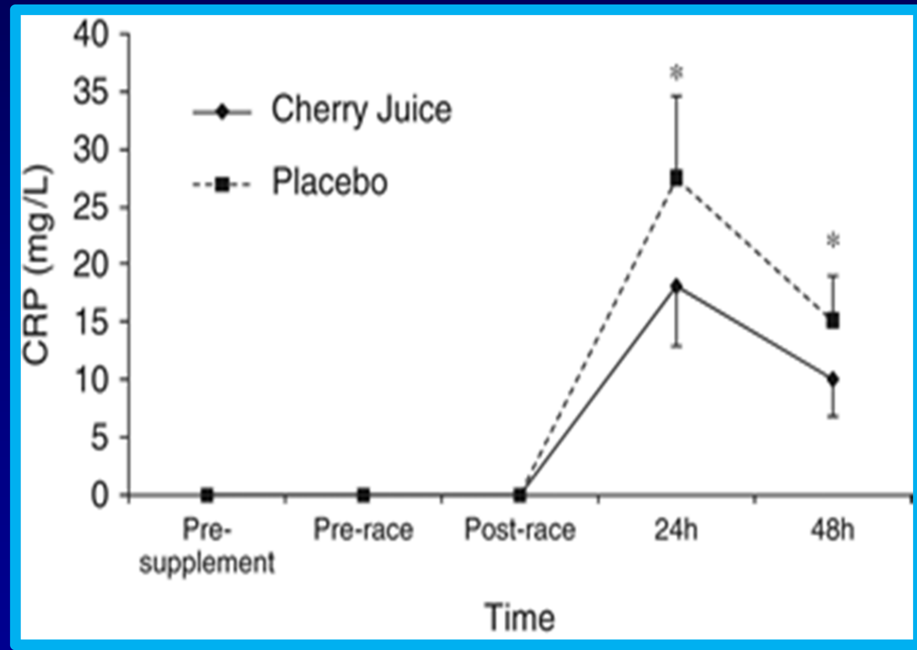


Baylor 2008 and Other Studies

- Connolly DAJ et al 2006, tart cherry juice for 8 d decreased the exercise-induced strength loss and pain in 14 male college students.
- 2 other recent studies; one with marathon runners and other with healthy older men and women. Both used tart cherry products
- Dr John Cush, 5/6 patients experienced noticeable relief from arthritis pain while taking capsules containing extract of cherries
- Arizona study in progress

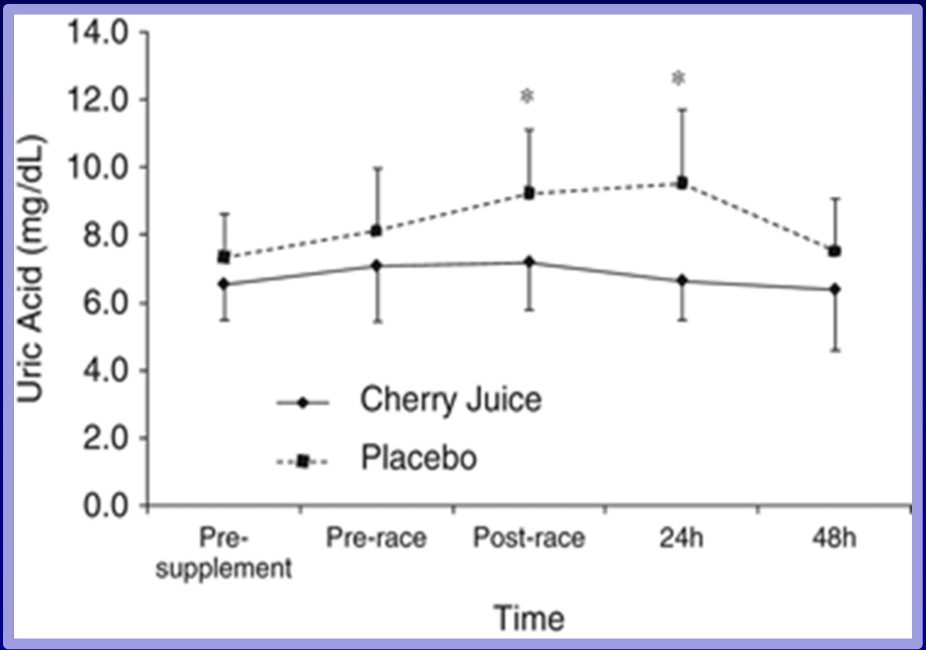
Effects of Tart Cherry Juice on IL-6 and CRP Post-Marathon Running

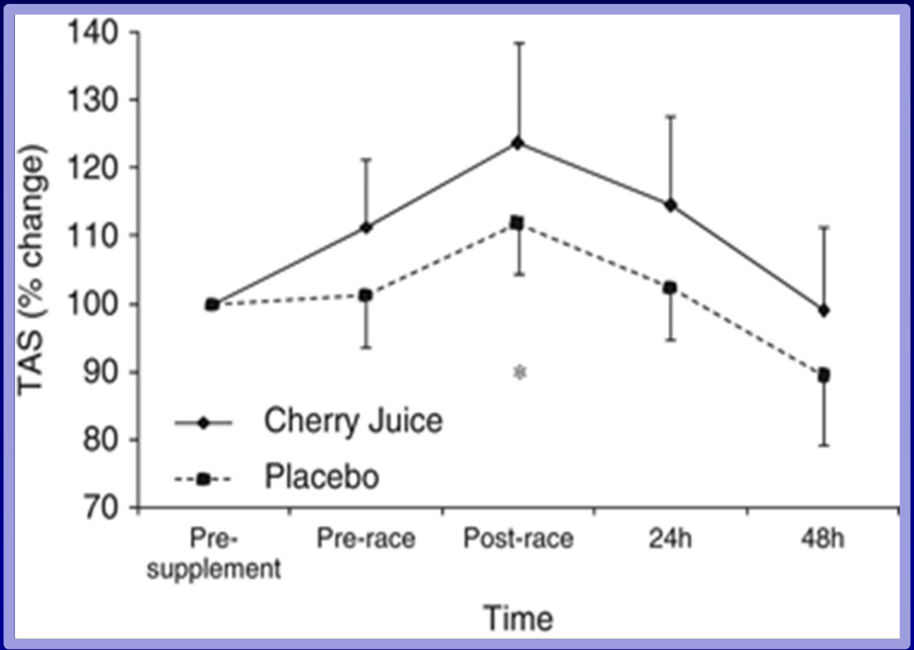




Howatson, G. et al. Scand J Med Sci Sports (2010) 20:843-852

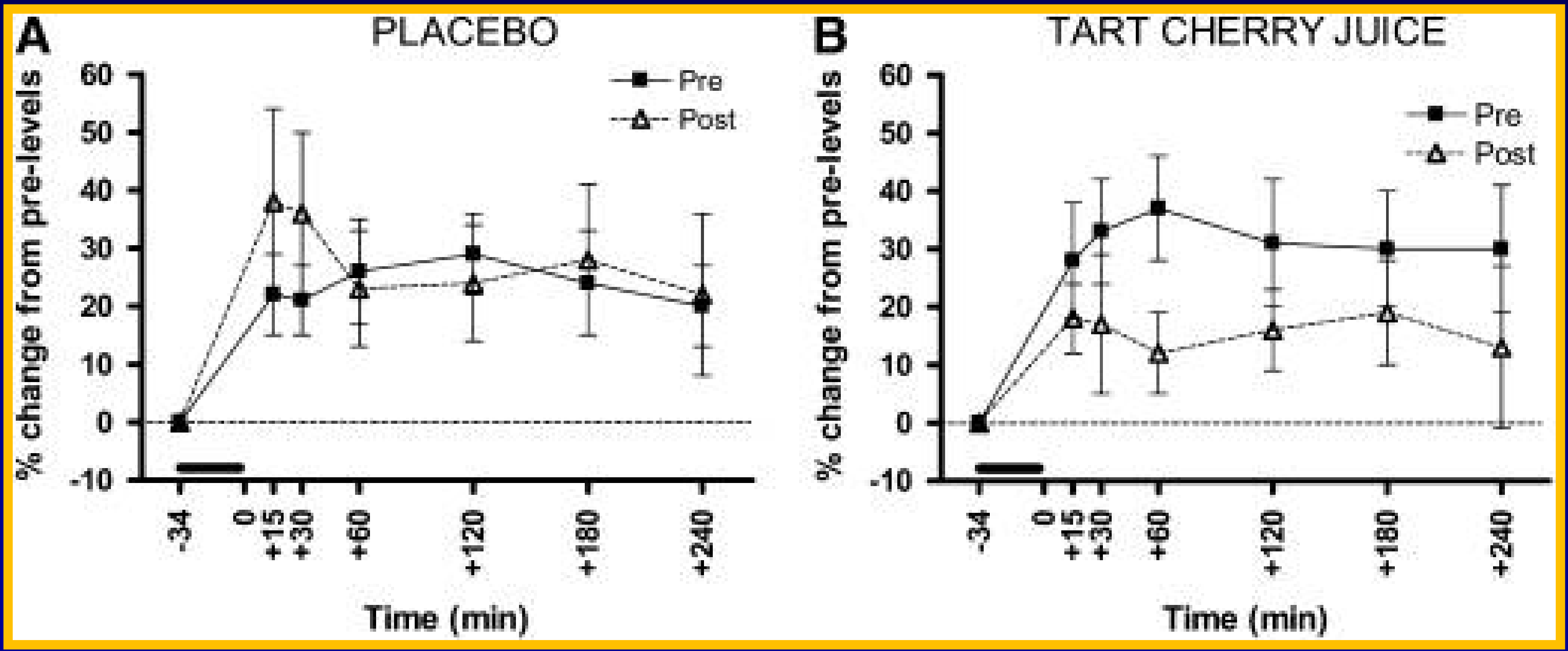
Effects of Tart Cherry Juice on Uric Acid and TAS Post-Marathon Running





Howatson, G. et al. Scand J Med Sci Sports (2010) 20:843-852

Plasma F2-isoprostane Responses to Acute Stress Exposure (Ischemia/Reperfusion Trials)



Traustadottier, T. et al. J. Nutr. (2009) 139:1896-1900

Summary and Conclusions

- Changes in plasma concentrations of biomarkers in our human study caused by cherries suggest potential decreases in:
- Inflammation (CRP, ferritin, IL-18, TNFa, IL-1Ra, ET-1, EN-RAGE, PAI-1)
- Arthritis (CRP, TNFa, IL-18, IL-1Ra)
- Diabetes and CVD (CRP, Ferritin, ET-1, EN-RAGE, PAI-1, IL-18)
- hypertension (ET-1)
- Cancer (EGF, ET-1),

Future Directions

- More studies with sweet cherries needed
- Develop standardized long lasting cherry products for intervention studies (canned/frozen cherries, juice, powder, extracts, food products)
- Dose response of cherries or cherry products
- **Intervention studies in people at risk (metabolic syndrome- AGE, IR, BP, lipids particle size and #)** diabetes, CVD, arthritis
- Identification of bioactive compounds

Collaborators

- California Cherry Advisory Board
- Washington State Fruit Commission
- Robert A. Jacob, PhD, WHNRC
- Adel A. Kader, PhD, UCD
- Bruce E. Mackey, PhD, WRRC
- Yuriko Adkins, PhD, WHNRC
- Kent Erickson, PhD, UCD

Foods for Health:
Examples of how WHNRC studies their effects on humans

Lindsay H. Allen, Ph.D.,Director, USDA-ARS

Western Human Nutrition Research Center

UC Davis, California

Center Director

14 Scientists

~85 staff, students

Scientist's Labs

Technicians

14 Postdocs

20 Grad students

Analytical Support Labs

Bioanalytical

Physiology

Minerals

UC Davis Cooperation

Microarray, transgenic mice, animal facilities

Human Studies

Non-residential, Residential

Research Interests

Metabolism & Obesity

- Obesity/energy (Keim)
- Metabolomics (Newman)
- Obesity/metabolism (Adams)
- Behavior (Laugero)
- Body comp. (Van Loan)
- Epidemiology (future)
- Micronutrients (Allen)
- (C-1 metabolism) (future)

Obesity

Mineral & vitamin fx.

Immunity, cancer, inflamm.

Cancer

Nutrition, Immunity & Disease Prevntn

- Vit A,D (Stephensen)
- Phytonutr. (Zunino)
- EFA, TLR (Hwang)
- EFA, phytonut (Kelley)
- Carotene (Burri)
- Se (Hawkes)
- Zn (Huang)

WHNRC measures impact of nutrition interventions

Interventions

Foods, nutrients

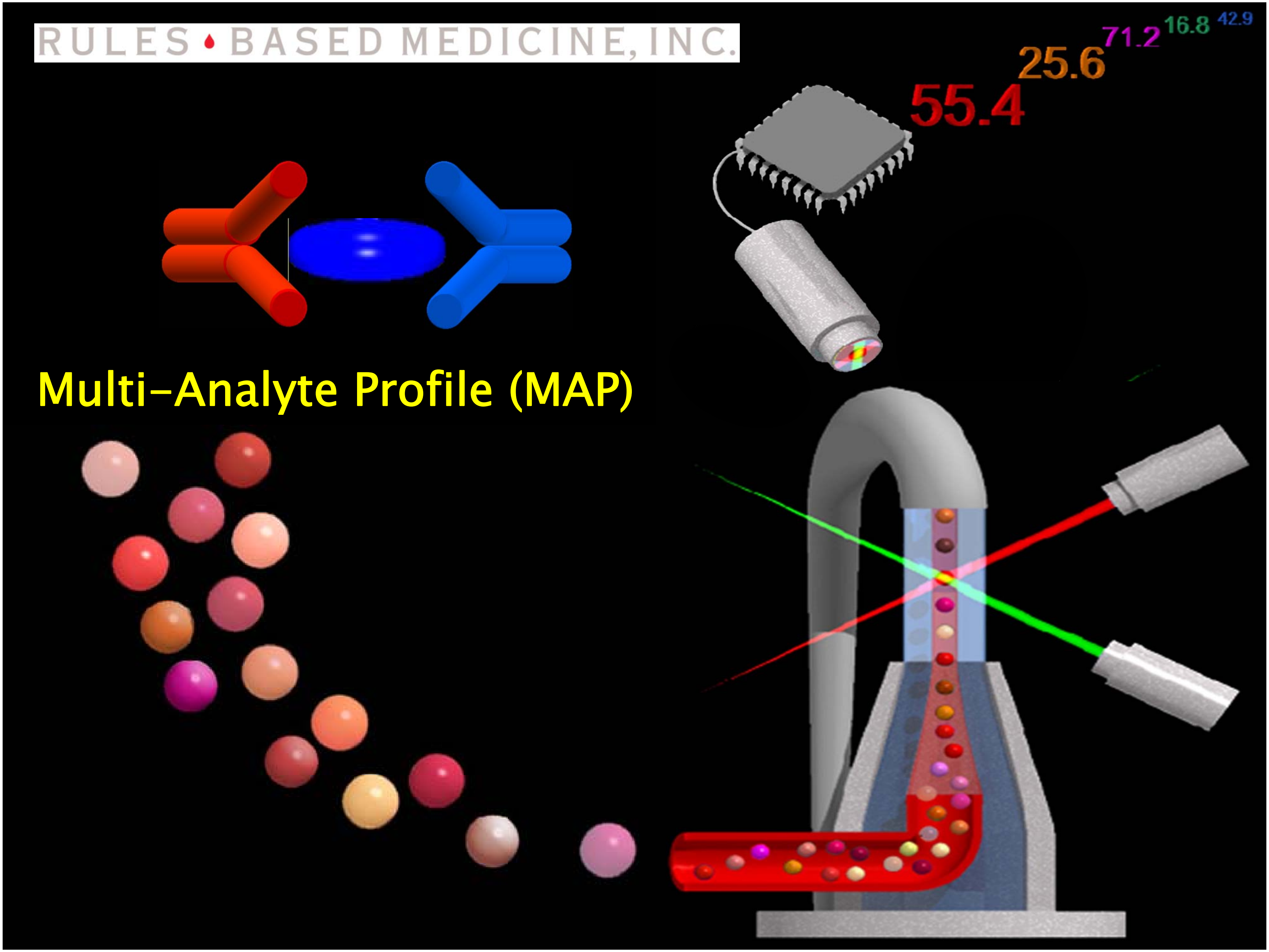
Metabolic response

- Energetic
- Metabolomic
- Genomic
- Endocrine
- Kinetic (AMS)

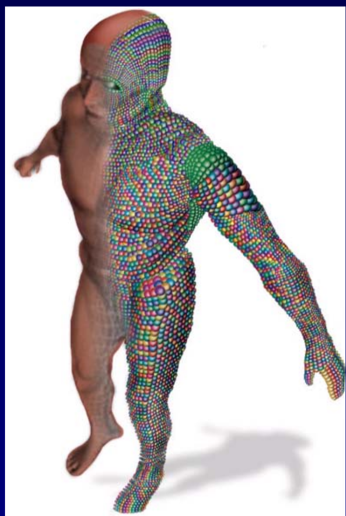
Functional response

- Immunity
- Inflammation
- Oxidative stress
- Cancer prevention
- Bone integrity
- Cognition

- Phenotype
- Genotype
- Activity, behavior


RULES • BASED MEDICINE, INC.
55.4
25.6
71.2
16.8
42.9
Multi-Analyte Profile (MAP)

RBM
RULES • BASED MEDICINE



HumanMAP version 1.6

The Human MAP measures 89 antigens using less than 100 µL of plasma

1. Adiponectin
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6. Apolipoprotein C-III
7. Apolipoprotein H
8. Beta-2 Microglobulin
9. BDNF
10. C-Reactive Protein
11. Calcitonin
12. Cancer Antigen 19-9
13. Cancer Antigen 125
14. Carcinoembryonic Antigen
15. CD40
16. CD40 Ligand
17. Complement 3
18. CK-MB
19. Endothelin-1
20. Eotaxin
21. Epidermal Growth Factor
22. ENA-78
23. Erythropoietin
24. ENRAGE
25. Factor VII
26. Fatty Acid Binding Protein
27. Ferritin
28. Fibrinogen
29. FGF-basic
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49. Interleukin-6
50. Interleukin-7
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77. Sex Hormone Binding Globulin
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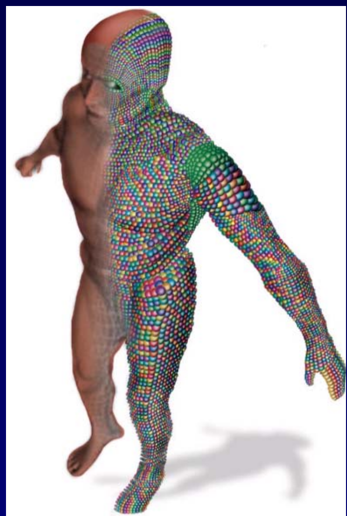
RBM
RULES • BASED MEDICINE



TruCulture™ MAP version 1.1

The TruCulture™ MAP measures 46 antigens using less than 250 µL of culture media

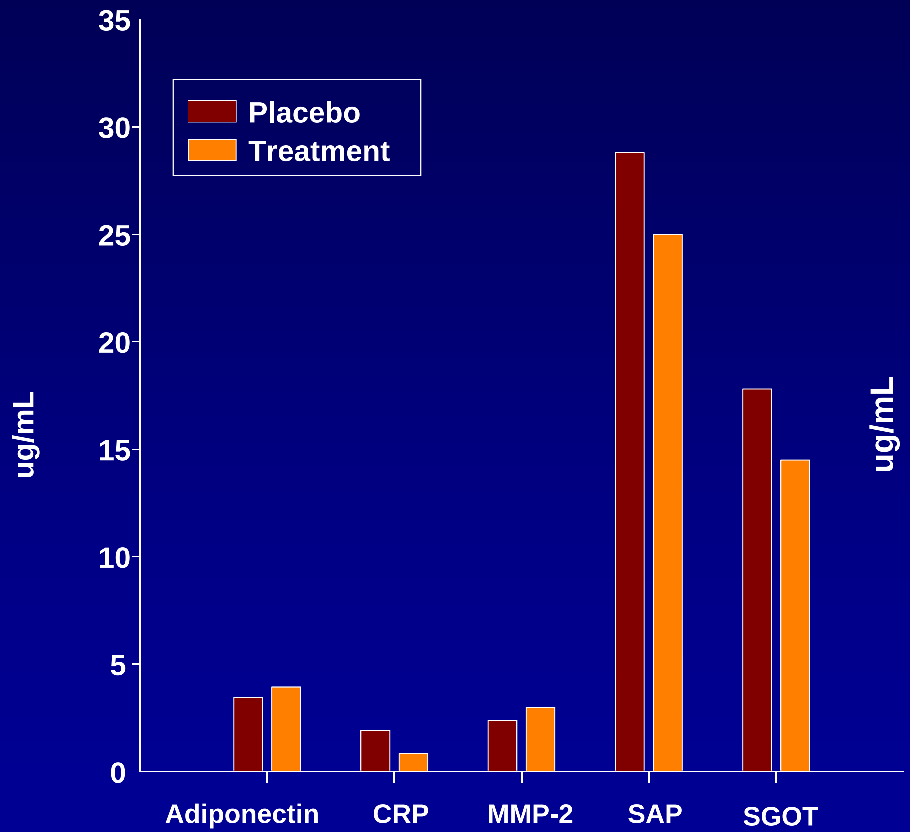
1. Alpha-1 Antitrypsin
2. Alpha-2 Macroglobulin
3. Beta-2 Microglobulin
4. Brain-Derived Neurotrophic Factor
5. C Reactive Protein
6. Complement 3
7. Eotaxin
8. Factor VII
9. Ferritin
10. Fibrinogen
11. GM-CSF
12. Haptoglobin
13. Intercellular Adhesion Molecule-1
14. Interferon gamma
15. Interleukin 1 alpha
16. Interleukin-1beta
17. Interleukin-1 receptor alpha
18. Interleukin-2
19. Interleukin-3
20. Interleukin-4
21. Interleukin-5
22. Interleukin-6
23. Interleukin-7
24. Interleukin-8
25. Interleukin-10
26. Interleukin-12 p40
27. Interleukin-12 p70
28. Interleukin-15
29. Interleukin-17
30. Interleukin-23
31. Matrix metalloproteinase type 2

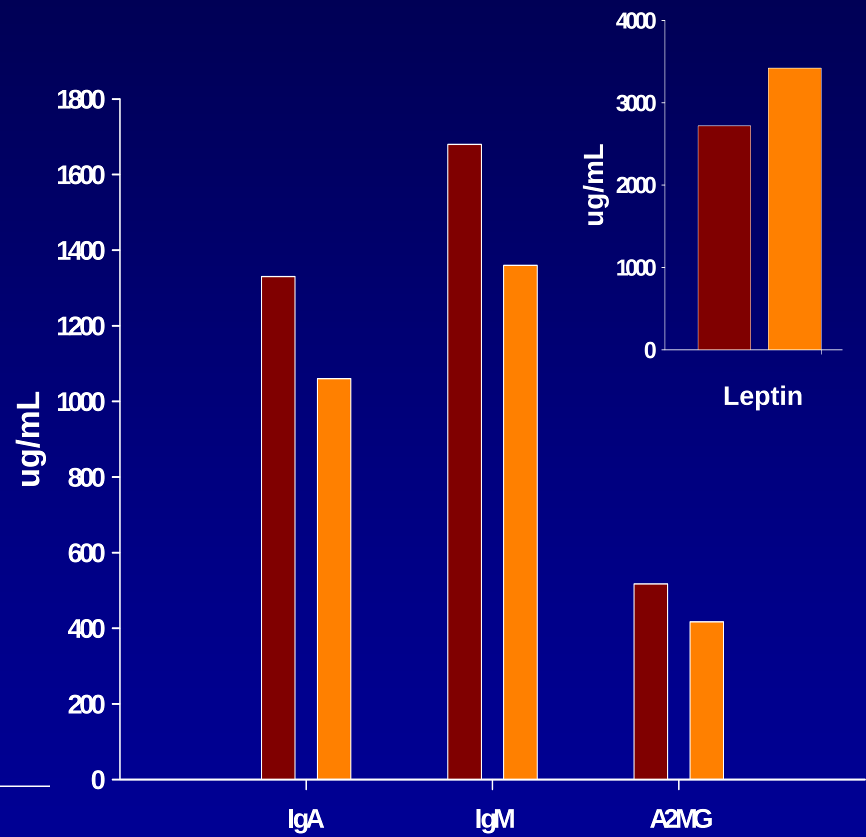
32 Matrix metalloproteinase type 3

33. Matrix metalloproteinase type 9
34. Macrophage Inhibitory Protein 1 alpha
35. Macrophage Inhibitory Protein-1 beta
36. Monocyte Chemotactic Protein-1
37. RANTES
38. Stem Cell Factor
39. Tissue Inhibitor of Metalloproteinase
40. Tumor Necrosis Factor alpha
41. Tumor Necosis Factor beta
42. Tumor Necrosis Factor receptor alpha 2
43. Vascular Cellular Adhesion Molecule type 1
44. Vascular Endothelial Growth Factor
45. von Willebrand's Factor
46. Vitamin D Binding Protein

RBM Human MAP Sensitivity

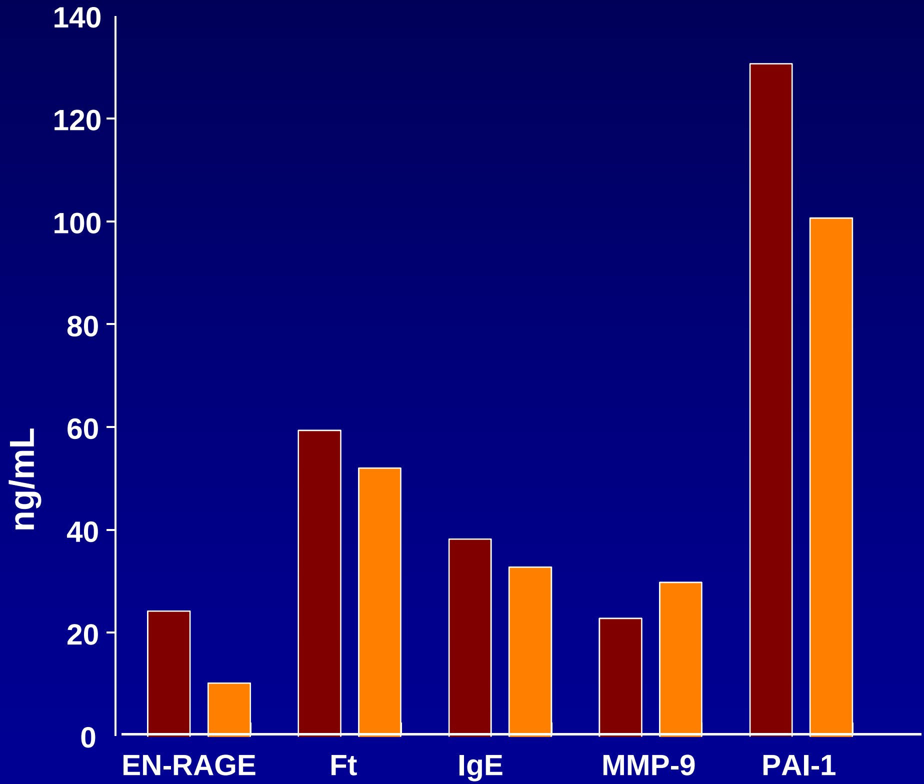
Effect of DHA on Markers of Inflammation and Insulin Resistance in Hypertriglyceridemic Men

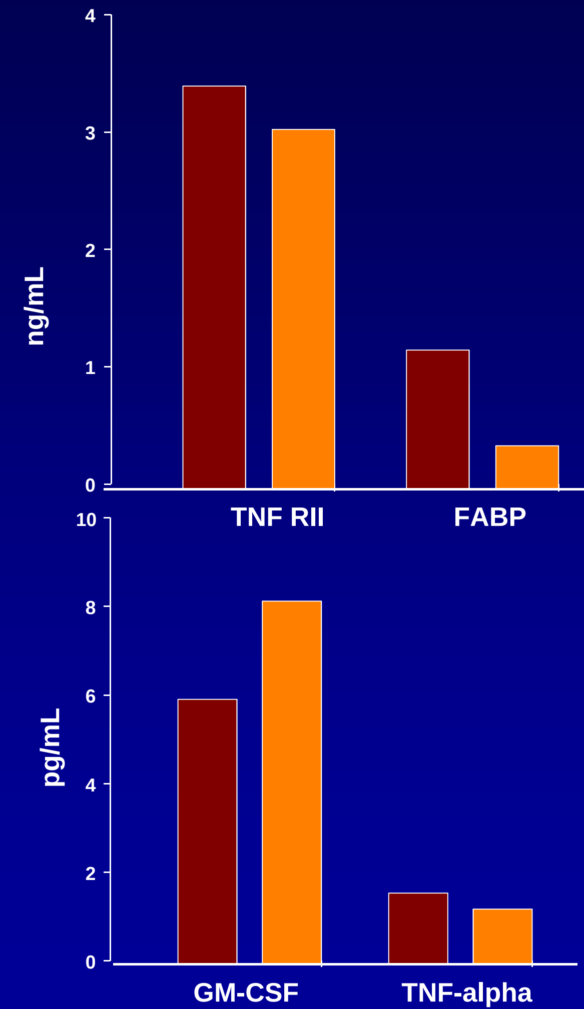




RBM Human MAP Sensitivity

Effect of DHA on Markers of, Inflammation, Infection, and lipid transport in Hypertriglyceridemic Men





Sweet Cherry Feeding Study in Overweight Males

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Figure 1. Consort diagram of the Sweet Cherry Feeding Trial

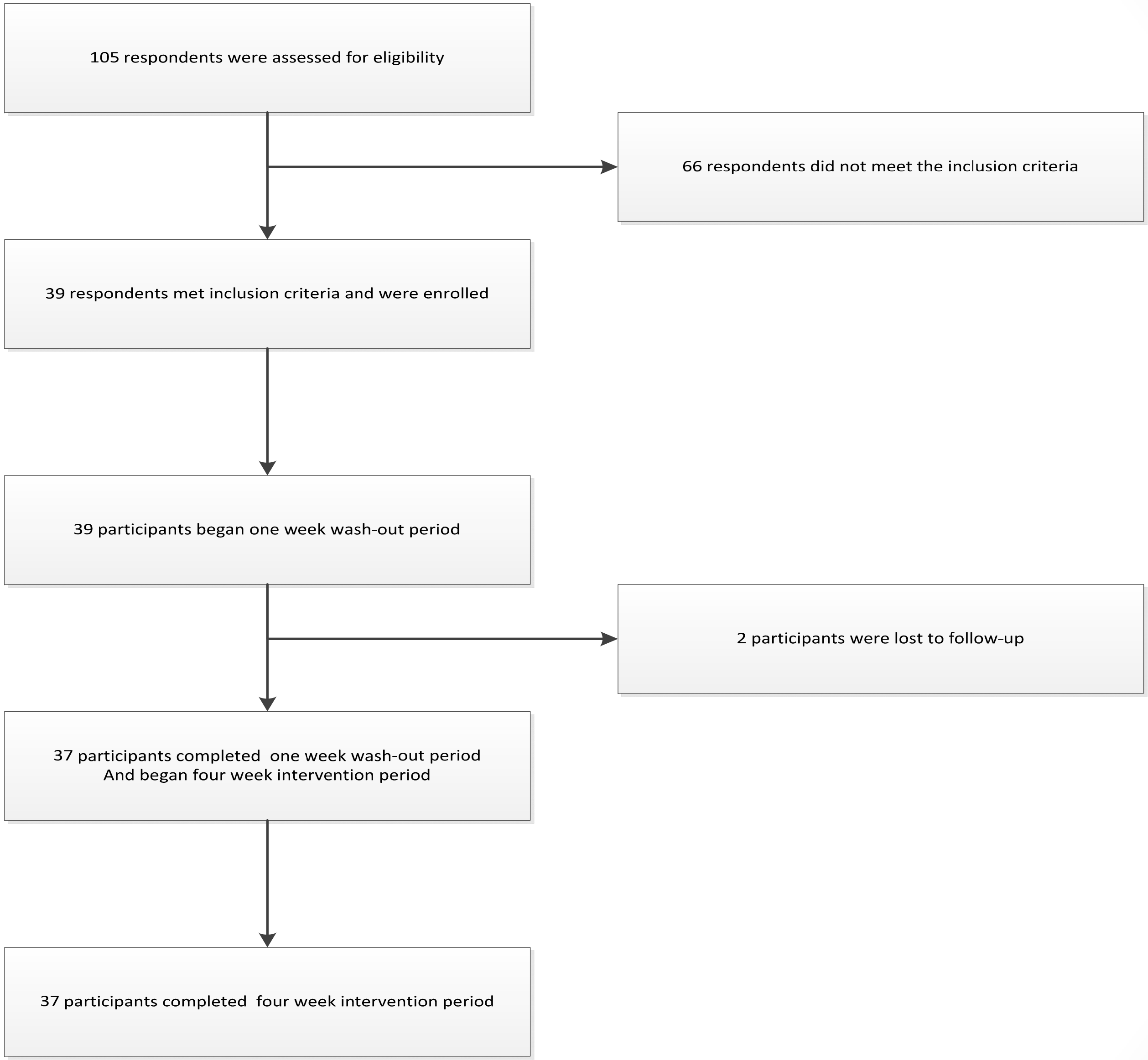


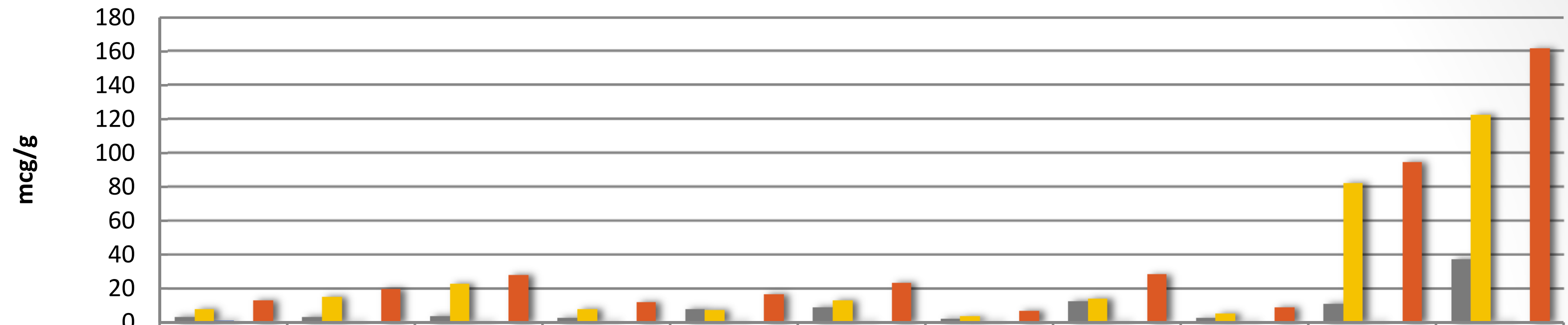
Table 1. Participant characteristics at baseline, mean ± standard deviation (SD) and median (25th, 75th percentiles) or n (percent of total; %) (n = 37)

Characteristic	mean ± SD	median (25th, 75th percentiles)
Age (y)	61.4 ± 7.7	60.0 (56.3, 64.2)
Weight (kg)	103.0 ± 12.9	104.1 (91.8, 110.0)
BMI (kg/m^2)	31.7 ± 4.3	31.3 (28.1, 34.2)
Body Fat (%)	31.8 ± 5.0	31.8 (28.2, 34.6)
Waist Circumference (cm)	112.0 ± 11.8	111.8 (104.1, 118.1)
Hip Circumference (cm)	109.5 ± 10.5	106.7 (101.6, 116.8)
Waist:Hip Ratio	1.02 ± 0.05	1.02 (1.0, 1.05)
Systolic (mmHg)	134.5 ± 10.6	134.0 (128.0, 141.0)
Diastolic (mmHg)	83.2 ± 9.4	85.0 (78.0, 90.0)
Heart Rate (bpm)	69.1 ± 9.8	68.0 (63.0, 75.0)
	n (%)	
Ethnicity		
Caucasian	33 (89.2)	
Other	4 (10.8)	
Highest Education Reported		
High School Degree or below	2 (5.4)	
Undergraduate Degree or below	19 (51.4)	
Graduate Degree or below	16 (43.2)	

Table 2. Comparison of circulating (plasma) and excreted (urine) anthocyanin levels detected versus below the limit of detection at baseline and end of study (n = 30)							
	Plasma, anthocyanin detected, n (%)				Urine, anthocyanin detected, n (%)		
Anthocyanin	Baseline	End of study	P-value		Baseline	End of study	P-value
C3GLU	16 (53.3)	6 (20.0)	0.006*		17 (56.7)	20 (66.7)	0.250
C3RUT	3 (10.0)	25 (83.3)	<0.001*		2 (6.7)	30 (100.0)	<0.001*
C3SAM	4 (13.3)	3 (10.0)	1.000		7 (23.3)	4 (13.3)	0.375
C3XRUT	0 (0.00)	0 (0.00)	1.000		0 (0.00)	0 (0.00)	1.000

***P< 0.05, as determined by using McNemar's test**

Figure 2. Anthocyanin content of cherries, by batch of cherries, overtime



	CA Brooks 23-May 1	CA Brooks 30-May 2	CA Tulare 3-Jun 3	CA Garnet 10-Jun 4	WA Bing 17-Jun 5	WA Chelan 24-Jun 6	WA Chelan 30-Jun 7	OR Chelan 8-Jul 8	WA Chelan 14-Jul 9	WA Bing 20-Jul 10	WA Cherry Red 27-Jul 11
C3GLU	3.7	3.68	3.99	3.22	8.32	9.43	2.41	12.98	2.76	11.4	37.68
C3RUT	8.13	15.35	23.36	7.97	7.51	13.34	3.81	14.62	5.61	82.44	122.73
C3SAM	1.64	1.05	1.01	0.96	1	0.96	0.96	0.96	0.95	1.05	1.15
C3XRUT	0	0	0	0	0	0	0	0	0	0	0
total ACN	13.47	20.08	28.36	12.15	16.83	23.73	7.18	28.56	9.32	94.89	161.56

Figure 2. Concentration of anthocyanins (ACN; in mcg/g) significantly increased overtime and differed by batch of cherries received. The following ACNs were quantified using liquid chromatography paired with tandem mass spectrophotometry (LC-MS/MS): Cyanidin 3-glucoside (C3GLU); cyanidin 3-rutinoside (C3RUT); cyanidin 3-sambubioside (C3SAM); cyanidin 3-(2(G)-xylosyl) rutinoside (C3XRUT); total ACN. Cherries were received from California (CA), Washinton state (WA) and Oregon (OR). Varietals of cherries included Brooks, Tulare, Garnet, Bing, Chelan and Cherry Red. *P*-values for trend were as follows: C3GLU $P = 0.041$; C3RUT $P = 0.040$; C3SAM $P = 0.221$; total ACN $P = 0.035$.

Table 3. Comparison of urinary and serum biomarker levels at baseline and end of study, total and stratified by above or below the median baseline levels (n = 37), median (25th, 75th percentiles) and P-value

Biomarkers at baseline	Baseline	End of study	P-value[1]
Urinary thromboxane B2 (ng/ml)	0.19 (0.15, 0.21)	0.19 (0.16, 0.24)	0.821
Below the median	0.15 (0.14, 0.16)	0.16 (0.13, 0.17)	0.051
Above the median	0.22 (0.20, 0.29)	0.24 (0.22, 0.30)	0.112
Urinary prostaglandin E2 metabolite (pg/ml)	131.4 (74.8, 290.3)	130.9 (88.9, 215.5)	0.268
Below the median	74.8 (53.4, 109.4)	88.9 (69.8, 97.5)	0.355
Above the median	303.2 (222.8, 415.2)	220.1(177.7, 381.5)	0.071
Serum C-reactive protein (mgL)	1.54 (0.92, 3.63)	2.20 (1.10, 3.31)	0.411
Below the median	0.92 (0.61, 1.48)	1.10 (0.48 – 1.59)	0.006*
Above the median	3.64 (2.48, 6.59)	3.40 (2.89, 7.69)	0.500
Serum homocysteine (µmol/L)	10.2 (8.6, 11.6)	9.5 (8.7, 12.0)	0.531
Below the median	8.6 (7.8, 9.8)	8.7 (7.9, 9.0)	0.644
Above the median	11.8 (11.3, 12.6)	12.1 (10.5, 13.5)	0.695
Did not use folic acid supplementation at baseline	10.9 (9.5, 11.9)	10.4 (9.0, 13.3)	0.361
Used folic acid supplementation at baseline	8.3 (7.8, 11.5)	8.9 (7.3, 10.2)	0.925

* P-value <0.05 as determined by either using paired, two-sided Wilcoxon signed rank sum test on non-transformed urinary and serum biomarkers

[1]P-value as determined by Wilcoxon signed rank sum test on non-transformed urinary and serum biomarkers

Table 4. End of study inflammatory biomarkers stratified by end of study total urinary anthocyanin content and estimated anthocyanin exposure from the diet, median (25th, 75th percentiles)		
Urinary anthocyanin tertiles	Serum C-reactive protein (mgL)	Urinary prostaglandin E2 metabolite (pg/ml)
1 (157.3 - 196.7)	2.01 (0.96, 3.48)	200.1 (93.4, 224.6)
2 (198.0 - 217.3)	2.15 (1.28, 3.04)	153.4 (100.7, 290.9)
3 (222.7 – 858.3)	2.66 (1.48, 4.43)	91.4 (81.0, 265.3)

*P < 0.05 as determined by Kruskal-Wallis test

4 participants with significant increases in the hcys (µmol/L)				
Participant ID	Baseline	End of study	Change	FA supp at baseline
11	13.7	17.5	3.8	No
25	10.9	16.2	5.3	No
30	10.1	16.9	6.8	No
8	14.7	25.8	11.1	Yes (752.1 µ/day)

Normal ranges for homocysteine are between 5-15 micromolar; over age 60 normal is < 11.4 micromolar

Elevated homocysteine have been seen in people with CVD; no evidence that lowering reduces CVD risk short-term

Alcohol and intense exercise may also increase levels

Note: Folic acid supplementation was discontinued before washout… unless it was in a multivitamin. Multivitamins were allowed to continue throughout the trial

Where next?

- Need standardized product to control intervention and reduce variance in results
- Dose was reasonable for whole foods; could increase specific anthocyanin exposure with targeted crop
- Consider recruiting higher risk group- baseline elevated inflammation; possibly oxidative stress also
- Will need to monitor homocysteine response; consider not changing vitamin use from habitual use
- Consider centralized small grant program that supports both basic and clinical research to advance knowledge

Discussion

- Are there holes in the research that need to be filled?
- Does the current research present any opportunities for further investigation?
- What research should be prioritized? Previous recommendation included arthritis, insulin resistance, and inflammation. Are these still relevant?
- What are hot research topics right now/ on the horizon?
- Recommended next steps?