The Chile Pepper: It’s Nutritious and Delicious!

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About the College: The College of Agricultural, Consumer and Environmental Sciences is an engine for economic and community development in New Mexico, improving the lives of New Mexicans through academic, research, and extension programs.
GOOD NUTRITION SIGNALS THE REALIZATION OF PEOPLE’S RIGHTS TO FOOD AND HEALTH. IT REFLECTS A NARROWING OF THE INEQUALITIES IN OUR WORLD.

Without good nutrition, human beings cannot achieve their full potential. When nutrition status improves, it helps break the intergenerational cycle of poverty, generates broad-based economic growth, and leads to a host of positive consequences for individuals, families, communities, and countries. Good nutrition provides both a foundation for human development and the scaffolding needed to ensure it reaches its full potential. Good nutrition, in short, is an essential driver of sustainable development.
Bad Nutrition Results in

- Thin, frail children and adults
- Underdeveloped and stunted children
- Weakened immune systems
- Obesity
- Diabetes
- Heart disease
- Some cancers

Causes of Bad Nutrition are

- Weak care of mothers and children
- Insufficient access to health services
- POOR QUALITY FOODS
World Health Organization Facts:

- 2 billion people experience micronutrient malnutrition
- 1.9 billion adults are overweight or obese
- 161 million children under age 5 are stunted
- 42 million children are overweight
- 1 in 12 adults worldwide have Type 2 diabetes
- Most of the world’s population live in countries where overweight and obesity kills more people than underweight

http://www.who.int/mediacentre/factsheets/fs311/en/
Metabolites are *bioactive* in animals.

- Anthocyanins
- Organic acids
- Phenolic acids
- Capsaicinoids
- Carotenoids
- Tocopherols
- Chlorophylls
- Ascorbic acid
Plant AgroEcology

- Plant interactions with the agricultural environment.
- Allows plants to make thousands of specialized metabolites

"From waste products to ecochemicals: Fifty years of research in plant secondary metabolism" Phytochemistry 68 (2007)
How are metabolites regulated in plants?

- Genotype (Genes) determines Phenotype (Physical trait)
- Understanding Vegetable AgroEcology includes
  - Field, Genetic, and Biochemical approaches
Chile Pepper Center of Origin

CENTERS OF ORIGIN FOR SOME HERBS AND SPICES

Illustration by Peggy Duke
Chile Pepper Domestication

- 5 different species
  - Capsicum annuum
  - Capsicum baccatum
  - Capsicum chinense
  - Capsicum pubescens
  - Capsicum frutescens
Chile Pepper Domestication

- Why were these 5 species domesticated by humans?

Any ideas?
Chile Pepper - An international ingredient
A New Mexican Staple

“Chile, they say, is the king, the soul of the Mexicans — a nutrient, a medicine, a drug, a comfort. For many Mexicans, if it were not for the existence of chile, their national identity would begin to disappear.”

Arturo Lomeli, El Chile y Otros Picantes (1986)
The Nutritious Capsicum

• Vitamins
• Micronutrients
• Medicinal
Health Promoting Vitamin E

- Essential vitamin
- Protect seed-storage lipids from oxidation
  - Antioxidant
  - Anti-inflammatory agents
  - Protection against degenerative diseases
- Found mostly in pepper fruit tissue
- Increases during ripening from green to ripe red
- Levels in dry red chile levels = levels in spinach (22.5 mg/100 g)
- 100 g dry red chile had twice as much alpha-toc as 100 g of soybean oil (10.7 mg)
- 100 g of dry red fruit would exceed the RDA (8-10 mg) for average adult

Immuno-Protective Vitamin C

Ascorbic acid
- Maintains health of skin, cartilage, teeth, bone, and blood vessels.
- Protects immune system.
- 15 to 277 mg/100 g fresh wt
- Ascorbic acid peaked
  - at the red succulent stage for Sandia
  - at the red partially dry stage for NuMex 6-4.

Kantar et al., 2016. Vitamin Variation in Capsicum Spp. Provides Opportunities to Improve Nutritional Value of Human Diets. PlosOne

Carotenoids: Nature’s Pigments

- >700 carotenoids
- Vitamin A Precursors
  - β-carotene
  - α-carotene
  - β-cryptoxanthin
- Essential to animal vision (retinals)
- Intestinal microbiome
- ~6-12 μg of β-carotene to 1 μg of Vitamin A
proVitamin A varies depending on genetics and environment.

<table>
<thead>
<tr>
<th>Species</th>
<th>Cultivar</th>
<th>Color</th>
<th>β-carotene</th>
<th>% of Total carotenoids Identified</th>
<th>Total Carotenoids</th>
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</thead>
<tbody>
<tr>
<td><em>C. annuum</em></td>
<td>Nambe</td>
<td>Red</td>
<td>0.58 ± 0.22</td>
<td>33.6 %</td>
<td>10.76 ± 2.54</td>
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<tr>
<td></td>
<td>NuMex Nematador</td>
<td>Red</td>
<td>0.56 ± 0.40</td>
<td>50.4 %</td>
<td>9.07 ± 2.00</td>
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<td></td>
<td>Giant Thai</td>
<td>Red</td>
<td>1.32 ± 0.26</td>
<td>37.7 %</td>
<td>6.55 ± 0.34</td>
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<td></td>
<td>Pimiento</td>
<td>Red</td>
<td>0.18 ± 0.03</td>
<td>55.0 %</td>
<td>5.68 ± 0.46</td>
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<tr>
<td></td>
<td>Andy</td>
<td>Red</td>
<td>0.42 ± 0.01</td>
<td>21.0 %</td>
<td>5.56 ± 0.52</td>
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<tr>
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<td>NuMex Garnet</td>
<td>Red</td>
<td>1.16 ± 0.05</td>
<td>34.0 %</td>
<td>5.34 ± 1.38</td>
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<td>Indian PC-1</td>
<td>Red</td>
<td>1.36 ± 0.11</td>
<td>47.9 %</td>
<td>3.76 ± 0.83</td>
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<td>Sandia</td>
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<td>0.39 ± 0.05</td>
<td>28.4 %</td>
<td>3.35 ± 0.56</td>
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<td>Blackbird</td>
<td>Red</td>
<td>0.09 ± 0.02</td>
<td>85.0 %</td>
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<td>Big Red Cayenne</td>
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<td>40.0 %</td>
<td>1.60 ± 0.15</td>
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<td>Hungarian Apple</td>
<td>Red</td>
<td>0.14 ± 0.0</td>
<td>29.6 %</td>
<td>1.52 ± 0.18</td>
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<td>Sweet Banana</td>
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<td>0.32 ± 0.09</td>
<td>59.4 %</td>
<td>0.69 ± 0.39</td>
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<td>NuMex Centennial</td>
<td>Red</td>
<td>0.12 ± 0.10</td>
<td>76.2 %</td>
<td>0.21 ± 0.08</td>
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<td></td>
<td>Go urmart Rainbow</td>
<td>Orange</td>
<td>0.50 ± 0</td>
<td>39.5 %</td>
<td>3.67 ± 0.00</td>
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<td></td>
<td>Costeno Amarillo</td>
<td>Orange</td>
<td>1.24 ± 0.04</td>
<td>43.8 %</td>
<td>3.52 ± 0.50</td>
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<td>Orange Thai</td>
<td>Orange</td>
<td>0.82 ± 0.07</td>
<td>46.5 %</td>
<td>2.45 ± 0.43</td>
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<td>Oriole</td>
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<td>0.28 ± 0.10</td>
<td>61.1 %</td>
<td>1.44 ± 0.42</td>
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<td>Early Sunsation</td>
<td>Orange</td>
<td>0.12 ± 0.06</td>
<td>54.3 %</td>
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<td>45.2 %</td>
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<td>Alba</td>
<td>Orange</td>
<td>0.01 ± 0</td>
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<td>0.15 ± 0.01</td>
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<td>0.04 ± 0.01</td>
<td>92.3 %</td>
<td>0.13 ± 0.01</td>
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<td>NuMex Thanksgiving</td>
<td>Orange</td>
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<td>80.0 %</td>
<td>0.05 ± 0.17</td>
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<td>Yellow</td>
<td>0 ± 0</td>
<td>40.0 %</td>
<td>0.30 ± 0.00</td>
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<td>Yellow Cheese</td>
<td>Yellow</td>
<td>0.04 ± 0.04</td>
<td>45.2 %</td>
<td>0.31 ± 0.00</td>
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<tr>
<td></td>
<td>Pimiento</td>
<td>Yellow</td>
<td>0 ± 0</td>
<td>100 %</td>
<td>0.01 ± 0.00</td>
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<tr>
<td><em>C. baccatum</em></td>
<td>Bolivian Yellow</td>
<td>Orange</td>
<td>0.20 ± 0.18</td>
<td>44.8 %</td>
<td>2.50 ± 1.20</td>
</tr>
<tr>
<td><em>C. chinense</em></td>
<td>Aji Dulce</td>
<td>Red</td>
<td>0.23 ± 0.04</td>
<td>59.1 %</td>
<td>1.10 ± 0.24</td>
</tr>
<tr>
<td></td>
<td>Jamaican Hot</td>
<td>Brown</td>
<td>0.20 ± 0.18</td>
<td>33.7 %</td>
<td>0.89 ± 0.43</td>
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<tr>
<td></td>
<td>Chocolate</td>
<td>Brown</td>
<td>0.28 ± 0.13</td>
<td>33.1 %</td>
<td>1.48 ± 0.70</td>
</tr>
</tbody>
</table>

Macular Degeneration Prevention and Cognitive Health

Lutein

Zeaxanthin
Folate, Vitamin B9

- 10 to 265 micrograms per 100 grams of pepper (1 bell pepper)
- RDA is 400 – 600 micrograms

Kantar et al., 2016. Vitamin Variation in Capsicum Spp. Provides Opportunities to Improve Nutritional Value of Human Diets. PlosOne
Anti-inflammatory Capsaicin

- Capsaicinoids
  - Capsaicin and capsaicin analogues
  - May function as neurotransmitters
  - Endorphins have been shown to be released in the brain when capsaicin is consumed
  - May help with reversibility of nerve damage

Biological Antioxidants

Chile nutrients quench free radicals

\[ \text{Car} + \text{Radical} \rightarrow \text{Car} + \text{heat} \]

- **Sources of Free Radicals:** Environmental pollutants, Radiation. Ultraviolet light, Pesticides, Industrial solvents

- **Effects of free radicals:** Cancers, Damaged DNA
Lots of Anti-oxidants

- Anthocyanins
- Polyphenols
Nutritious and **DELICIOUS**!

Over 200 compounds involved in bell pepper flavors
Flavors are complicated.

- Carotenoids
- Capsaicinoids
- Polyphenols

Flavor
Capsaicinoids

- More than 20 capsaicinoids.
- Bind to pain receptors (VR1) in our mouths.
- Scoville Heat Units are named after the psychophysiologist, Wilbur Scoville, and measure heat level.
  - Bell pepper = 1-1,000 SHU
  - Bhut Jolokia = more than 1,000,000 SHU
  - Trinidad Scorpion = more 1.5 million SHU
Chile Heat Profiles

- Chiles make different mixtures of capsaicinoids.
- Dependent on species and pod type.

Heat Profile Components
1) Development
2) Duration
3) Location
4) Feeling
5) Intensity

The Flavor Wheel, Chile Pepper Institute, Las Cruces, NM
Chile Heat Profiles

Jalapeño
*Capsicum annuum*

1) Rapid
2) Gradual loss of heat
3) Tip of tongue
4) Flat
5) Hot

Rocoto
*Capsicum pubescens*

1) Rapid
2) Long lingering heats
3) Whole mouth effect
4) Incredibly sharp
5) Very hot
Carotenoids

• Precursors to Flavor
  • Carotenoids breakdown to floral “peachy” flavor compounds
  • Examples:
    • Beta-ionones – rose, peach, black tea, mango
    • Alpha-ionones – black currant, plum, blackberries
    • Beta-Cyclocitral - Cantaloupe, Apricot, Melon
Variables Influencing Flavors

- Individual Biology
  - Primates on different continents developed unique receptors depending on available food
- Personal & Cultural Preferences
- Plant Genetics
- Postharvest Processing
Factors Influencing Compound Metabolism

- Cultivar/Variety
- Plant Organ
- Stage of Maturity
- Agronomic Practices
- Light and Temperature
- Harvesting/Postharvest

- Photosynthetic lipophilic compounds
- Prevent photooxidative damage
Postharvest Culinary Processing

How many ways can you process peppers?

A) 1
B) 2
C) 3
D) 4
E) 5

1. Fresh
2. Dried
3. Roasted
4. Sauteed
5. Pickled
Chile Pepper Chemistry

Nutritional  Medicinal  Flavorful
95% carotenoids from 250 mL mango puree were captured in 25 mL of sunflower oil

- 1 mg mango polyphenols/g flour
- Soy flour, Roasted peanut flour
Obesity Trends* Among U.S. Adults

1990

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

1991

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
1993

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

1995

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
1997

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
2000

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults 2001

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

2003

(*BMI ≥ 30, or ~ 30 lbs. overweight for 5' 4" person)
Obesity Trends* Among U.S. Adults
2004

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
2005

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
2006

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
2007

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
2008

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
2009

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)

[Map showing obesity trends among U.S. adults in 2009, color-coded by percentage of obese population.]
Obesity Trends* Among U.S. Adults
2010

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
New Mexico Health Facts:

• 10 food deserts in Doña Ana county
• A community that has low-income families and low access to a supermarket or large grocery store
• NM has 17.2% food insecurity rate
• National rate is 15.4%
• 9.8 % rate of diabetes
• Slightly higher than national rate
Get Healthy TODAY

- Choosemyplate.gov
- >25% of your plate should be vegetables
- Include a variety of colored vegetables

Eat green, yellow and red peppers!
Thank You!

- Krystal Vargas, NMSU undergraduate lab assistant

- Dr. Paul Bosland
  - Chile Pepper Institute

- Dr. Mary Ann Lila
  - Bill and Melinda Gates Foundation
  - Plants for Human Health Institute at North Carolina State University