

COLOR OF FOOD

Whole Food Insights



WholisticMatters™

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Phytonutrients and Color

WHAT ARE PHYTONUTRIENTS?

Phytonutrients are natural, plant-derived compounds that support life and offer protection – innately in plants but for plant-eating humans as well. For example, a 2014 meta-analysis found that the more vegetables eaten, the lower the risk of all-cause mortality.¹

WHY CARE ABOUT PHYTONUTRIENTS?

The human body needs phytonutrients in a different way than it needs nutrients like protein, vitamins, and minerals. Phytonutrients are uniquely able to satisfy free radicals circulating in the body looking for electrons. By providing electrons, phytonutrients prevent free radicals from taking electrons from proteins or other nutrients, a “theft” that leads to oxidative stress.

HOW ARE PHYTONUTRIENTS AND FOOD COLOR CONNECTED?

Different plant colors are associated with the beneficial protection of phytonutrients, and encouraging diversity of plant-based colors in a given meal can be a great method for improving diet choices.



WHAT HEALTH BENEFITS DO PHYTONUTRIENTS AND COLOR PROVIDE?

The colors of food have long been associated with improving health conditions. Green foods help improve diabetes and immunity, protect against cancer, and enhance gene expression. Red foods align with the cardiovascular system by protecting the heart and blood vessels. Red is also responsible for building muscle mass and skin protection. White foods, even though not as 'colorful', still yield a tremendous amount of immune system support by decreasing allergies, reducing inflammation, helping to maintain weight, and lowering cholesterol. Purple improves memory, protects against cancer, improves the gut, and keeps a healthy heart. Yellow or orange foods additionally protect the gut, protect our eyes and skin, fight cancer, and improve immunity.²

² NC State University Plants for Human Health Institute. Color Me Healthy.



MAJOR PHYTONUTRIENTS	POTENTIAL HEALTH ASSOCIATIONS
Anthocyanidins	Purple and red pigments with strong antioxidant and anti-inflammatory activity
Avenanthramides	Phenolic acids with antioxidant and anti-inflammatory activities with a bitter perception
Betalains	Natural pigments with antioxidant, anti-cancer, anti-lipidemic, and anti-microbial properties
Carotenoids	Antioxidants with anti-cancer potential and may lower risk of macular degeneration
Chlorophyll	Green pigment in plants with potential anti-inflammatory, antioxidant and anti-bacterial activity
Ellagic Acid	Potent antioxidant compound with anti-cancer potential
Fiber	Broad class of non-digestible materials (including soluble and insoluble types) that promote healthy cholesterol levels, promote cardiovascular health, support healthy bowel function
Flavanols	Promote antioxidant activity and promote vascular health
Flavanones	Colorless flavonoid compounds with antioxidant activity
Flavones	Promote antioxidant, anti-cancer, antimicrobial and anti-inflammatory activity
Flavonols	Phytoactive compound with anti-inflammatory, antimicrobial and anti-cancer activities
Functional Enzymes	Enzymes found in plant tissue that can support breakdown and/or conversion of substances to support aspects of an individual's health

MAJOR PHYTONUTRIENTS	POTENTIAL HEALTH ASSOCIATIONS
Glucosinolates	Sulfur-containing secondary metabolites mostly found in cruciferous vegetables, when activated by myrosinase from the plant or after ingestion by gut bacteria, associated with positive effects stemming from antioxidant activity such as cardio-protection and detoxification support
Isoflavonoids	Phenolic compounds with direct antioxidant effects
Lignans	Large plant polyphenolic compounds that bypass human digestion, feed gut bacteria, and provide antioxidant activity
Nitrates	Supports exercise performance and cardiovascular health
Phenolic Acids	Phytoactive compounds that promote antioxidant activity and promote vascular health
Saponins	Support the immune system and promote healthy cholesterol and blood glucose levels
Tannins	Large set of diverse phenolic compounds found in plants that contribute to antioxidant activity, antimicrobial action and distinct dark color

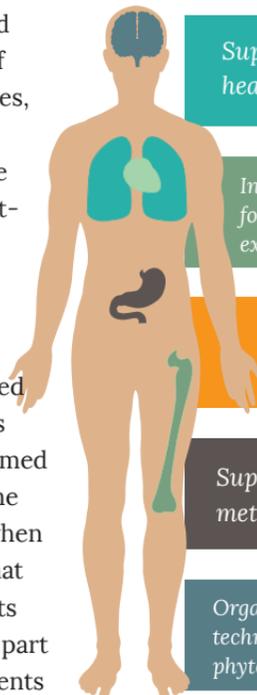
WHAT IS GAE? A WAY TO CAPTURE TOTAL PHENOLICS

Scientists can quantify “total phenolics” between different plants by measuring Gallic Acid Equivalence (GAE), which can be used to compare the amounts of phytonutrients and the total phenolic compound content of different foods. Phenolics are a group of phytonutrients that include phenolic acids, stilbenes, flavonoids, and condensed tannins. Phenolics are universally present in plant-derived foods and have been long-linked to the health properties of a plant-based diet.

WHAT IS THE WHOLE FOOD ADVANTAGE?

The idea of the “whole food advantage” describes the concept that bioactive phytonutrients consumed from whole foods produce stronger health benefits than when the phytonutrient is isolated and consumed alone.^{3,4} This idea also includes the notion that some phytonutrients in foods have a synergistic effect when eaten together. Plants have a predominant color that we see, but they also have additional phytonutrients associated with colors seen in other plants. This is part of the whole food advantage – multiple phytonutrients associated with multiple health benefits in just one plant.

The Whole Food Advantage



Supports balance immune modulation for healthy inflammation response.

Increased intake of vegetables and fruits in whole food nutrition influences individual epigenetic expression of our health potential.

Benefits of nutrients food matrix enhances bioavailability by up to 60%.

Supports the gut microflora and a healthy metabolic fingerprint of the gut.

Organic and adaptive regenerative farming techniques delivers nutrient dense source of key phytonutrients and helps balance healthy lifestyles.

³ Lila, MA and Raskin, I. J Food Sci. 2005; 70(1):R20-27.

⁴ Lila, MA. Ann NY Acad Sci. 2007. 1114:372-380.

Organic and Sustainable Farming

HOW DOES ORGANIC AND SUSTAINABLE FARMING PLAY A ROLE?

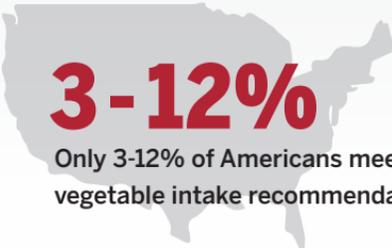
Organic and sustainable farms start with a foundation of healthy soil. Healthy soil contains rich biodiversity such as bacteria, fungi, minerals, and other organic matter. This biodiversity promotes water retention, erosion resistance, and higher yield of more nutrient-dense crops.



Phytonutrient Gap



10 servings of fruits and vegetables per day can add years to your life.



3-12%

Only 3-12% of Americans meet fruit and vegetable intake recommendations.^{8,9}



8 out of 10 Americans have some sort of gap in phytonutrient intake.^{8,9}



The biggest gap is the **blue/purple** fruit and vegetable group, with only **12%** of people meeting the median intake of those phytonutrients.



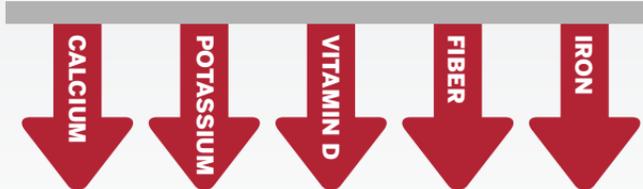
While the number of Americans consuming **green** fruits and vegetables is slightly higher, the percentage is still under **30%** of the recommended intake.^{8,9}

⁸ National Center for Health Statistics (NCHS). 2008. National Health and Nutrition Examination Survey Data 2005-2006. Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

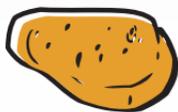
⁹ National Center for Health Statistics (NCHS). 2007. National Health and Nutrition Examination Survey Data 2003-2004. Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

Nutrient Gap

5 SHORTFALL NUTRIENTS



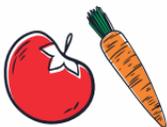
These 5 nutrients fall short in American diets and are of public health concern.^{10,11}



Potatoes account for more than **25%** of all vegetable consumption.^{12,13}



More than **80%** do not eat enough green vegetables.^{12,13}



More than **90%** do not eat enough orange and red vegetables.^{12,13}

¹⁰United States Department of Health and Human Services and United States Department of Agriculture. 2015–2020 Dietary Guidelines for Americans. 8th ed. U.S. Government Printing Office; Washington, DC, USA: 2015.



Daily vegetable intake should be **2.5 cups**.^{12,13}



Daily fruit intake should be **2 cups**.^{12,13}



More than **90%** of Americans do not meet this minimum.^{12,13}

¹¹Papanikolaou, Y and Fulgoni, Victor L. *Nutrients* 2018; 10(5):534.

¹² Dietary Guidelines Advisory Committee. 2015. *Scientific Report of the 2015 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Health and Human Services and the Secretary of Agriculture*. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.

¹³ U.S. Department of Agriculture, Agricultural Research Service, Beltsville Human Nutrition Research Center, Food Surveys Research Group (Beltsville, MD) and U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics (Hyattsville, MD). *What We Eat in America, NHANES 2007–2010*.

Green



Foods

Alfalfa

Barley Grass

Broccoli

Brussel Sprouts

Cabbage

Chard

Collard Greens

Kale

Kalette

Lettuce

Peas

Turnip Greens

Spinach

Phytonutrients:

Chlorophyll

Lutein & Zeaxanthin

Isoflavones

Isothiocyanates

Phytocannabinoids

Myrosinase



Black



Foods

Alfalfa

Barley

Black Beans

Black Eyed Peas

Chickpeas

Cinnamon

Cloves

Hemp

Oats

Spanish Black

Radish

Sorghum

Phytonutrients:

Tannins

Saponins

Phytocannabinoids



White



Foods

Apples	Garlic	Radish
Barley	Mushrooms	Tofu
Beetroot	Oat	
Buckwheat Seed	Onion	

Phytonutrients:

Phenolic Acids

Flavanols

Allicin



Yellow/Orange



Foods

Carrots	Pineapple
Citrus Fruit	Sweet Potato
Lemons	Tumeric
Oranges	Winter Squash
Peppers	Yellow Squash

Phytonutrients:

Beta Carotene

Beta Cryptoxanthin

Betaxanthins

Flavones

Curcumin

Bromelain

Flavanones



Purple



Foods

Acai	Cranberries	Red Cabbage
Aronia Berry	Currants	Red Wine
Blueberries	Eggplant	Whole Buckwheat
Cherries	Elderberry	Plant

Phytonutrients:

Anthocyanidins

Procyanidins

Stilbenes

Resveratrol



Red



Foods

Beets	Pink Grapefruit	Swiss Chard
Cherries	Pomegranates	Tomatoes
Chilies	Raspberries	Watermelon
Peppers	Strawberries	

Phytonutrients:

Lycopene

Nitrate

Betacyanins

Ellagic Acid

Capsaicin



Brown



Foods

Apricot

Beans

Cocoa

Figs

Flaxseed

Green Banana

Lentils

Mushrooms

Nuts

Oats

Potato

Rye

Tea

Phytonutrients:

Lignans

Beta Glucans

Theobromine

Resistant Starch

Other Fibers



FRUIT AND VEGETABLE SERVING EXAMPLES

Consumption of fruits and vegetables in America is subpar, yet we know that 10 servings of fruits and vegetables per day can add years to your life. While 10 servings may seem daunting, if you break it into meals and snacks throughout the day, it is actually quite manageable.

For example, along with your other protein, fat, and carbohydrate sources, 10 servings of fruits and vegetables could look like this during the day.



WHAT DOES A DAY OF COLORFUL EATING LOOK LIKE?

	Item	Serving	Color
BREAKFAST:	½ cup cooked red bell peppers	1 serving	1 red
	½ cup cooked spinach	1 serving	1 green
	1 cup raw blueberries	1 serving	1 blue
SNACK:	1 apple	1 serving	1 white
LUNCH:	3 cup loose spinach mix	1 serving	1 green
	1 cup chopped raw carrot, cucumber, radish mix	1 serving	1/3 green 1/3 white 1/3 orange
SNACK:	1 cup raw cherry tomatoes	1 serving	1 red
DINNER:	½ cup cooked cauliflower	1 serving	1 white
	½ cup cooked broccoli	1 serving	1 green
	1 small cooked sweet potato	1 serving	1 orange

TOTAL: 10 SERVINGS

**2 RED
3 1/3 GREEN
1 BLUE
1 1/3 ORANGE
2 1/3 WHITE**

About the Series

COLOR OF FOOD SERIES

This overview booklet is just one part of a multi-faceted series on the Color of Food. Understanding the significance of phytonutrient and nutrient gaps, the GAE connection, and the whole food advantage provides the tools needed to make conscious decisions about our health and the health of the people around us.

Please check out other items in the Color of Food Series:

- *Featured Crops: Nutrient and Phytonutrient Profiles*
- *Fruits and Vegetables*



We are dedicated to advancing the latest insights and information available in nutrition therapy and clinical nutrition and to presenting only the most balanced, credible, and reliable clinical nutrition and science available.

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