Antioxidant powerhouses and more…

100% Grape Juice from Concord and Niagara Grapes

The importance of dietary antioxidants in the prevention of chronic disease is an expanding area of focus for nutrition science and research today. Epidemiologic data clearly indicate that diets high in fruits and vegetables play a role in reducing the risk of chronic diseases like heart disease[1-3] and cancer,[2-4] and possibly progressive age-related conditions like Alzheimer's Disease.[5]

As our recognition of the need for dietary antioxidants increases, we are also finding that our understanding of what constitutes antioxidants is changing. The narrow definition of antioxidants as comprising mainly vitamins A, C and E now appears simplistic, replaced by a growing belief that the benefits derived from a diverse, plant-based diet likely come from a synergy between a wide range of bioactive compounds found in fruits and vegetables. With this new understanding comes a new term — "phytochemicals" or, better still, "phytonutrients".

The term "phytonutrients" is derived from the Greek word *phyto*, meaning plant. These "plant nutrients" can be defined as bioactive plant compounds found in fruits, vegetables, grains and other plant foods that have been linked to reducing the risk of major chronic diseases[6] — in part due to their potent antioxidant properties. While technically not yet recognized as nutrients, they are being actively studied for their potential contribution to health beyond basic nutrition.[7] Bioactive phytonutrients, found in significant amounts in plant-based foods, may be the key behind such now-familiar concepts as "the French Paradox" and "the Mediterranean Diet".

In keeping with this broader mindset, nutrition science is now looking at measurements like oxygen radical absorbance capacity (ORAC) and total antioxidant capacity (TAC) as guides to the antioxidant benefits a given food may or may not provide. Using these methodologies, the USDA has begun assembling a database of the antioxidant capacity of common foods.[8] This is a massive undertaking, and it is understandably incomplete. The antioxidant capacity of some common foods and beverages is listed inside.

One widely studied group of phytonutrients is the polyphenolics. (A classification of dietary polyphenolics is provided inside.) Polyphenolics act as defense mechanisms against pathogens, parasites and predators in the plants. In some cases, they contribute to the color of the plants themselves. Flavonoids are a subgroup of polyphenolic compounds that are recognized for their antioxidant capacity. These include the anthocyanins, the compounds responsible for giving blue and purple fruits their dark coloring, and the proanthocyanidins, a particularly promising set of compounds for which the USDA has developed its own dedicated database.[9]

Antioxidants serve several functions in the body that can contribute to healthy physiological function. One of the outcomes of oxidation is the production of compounds in the body called "free radicals". These free radicals can attack otherwise healthy cells and cause damage to cells, which many medical researchers believe presents an increased risk for cancer.[10] Free radicals can also disable helpful compounds like nitric oxide, which is closely linked to several mechanisms of healthy cardiovascular function.[11] Increasing the body's natural antioxidant capabilities quenches existing free radicals and reduces the production of new ones. Consumption of fruits, vegetables and whole grains has long been linked to reduced risk of chronic disease.[2] The antioxidative compounds in these foods are thought to be responsible for at least a portion of that reduced risk.

Beyond their direct antioxidant effect, phytonutrients may offer positive contributions in other ways as well. Concord grape juice is a good example. It has an extremely high antioxidant capacity, and subjects drinking this juice in clinical studies have shown a number of positive, antioxidant-related outcomes such as increased plasma antioxidant capacity, decreased superoxide production, and slowed LDL oxidation.[12] At the same time, subjects have also shown enhanced arterial function, improved endothelial function and decreased platelet aggregation[13] — positive cardiovascular outcomes that are due to more than just the phytonutrients' antioxidant function. Likewise, in laboratory animal studies, both blueberries and Concord grape juice have shown some ability to enhance motor skills and cognitive function in ways that appear to be unrelated to antioxidant function.[14] Fruits high in polyphenolics have shown antiproliferative activities in laboratory studies.[15] This may or may not be specifically related to antioxidant function.

As is often the case, the emerging study of phytonutrients raises more questions than science can definitively answer. What the data suggest, however, is that the benefits of a high fruit and vegetable diet are likely due to the complex synergy among the hundreds of phytonutrients found in these foods, and not the result of a handful of easily identified antioxidants. Because some foods contain certain groups of phytonutrients and other foods contain other types, it makes sense to eat a wide variety of colorful foods.

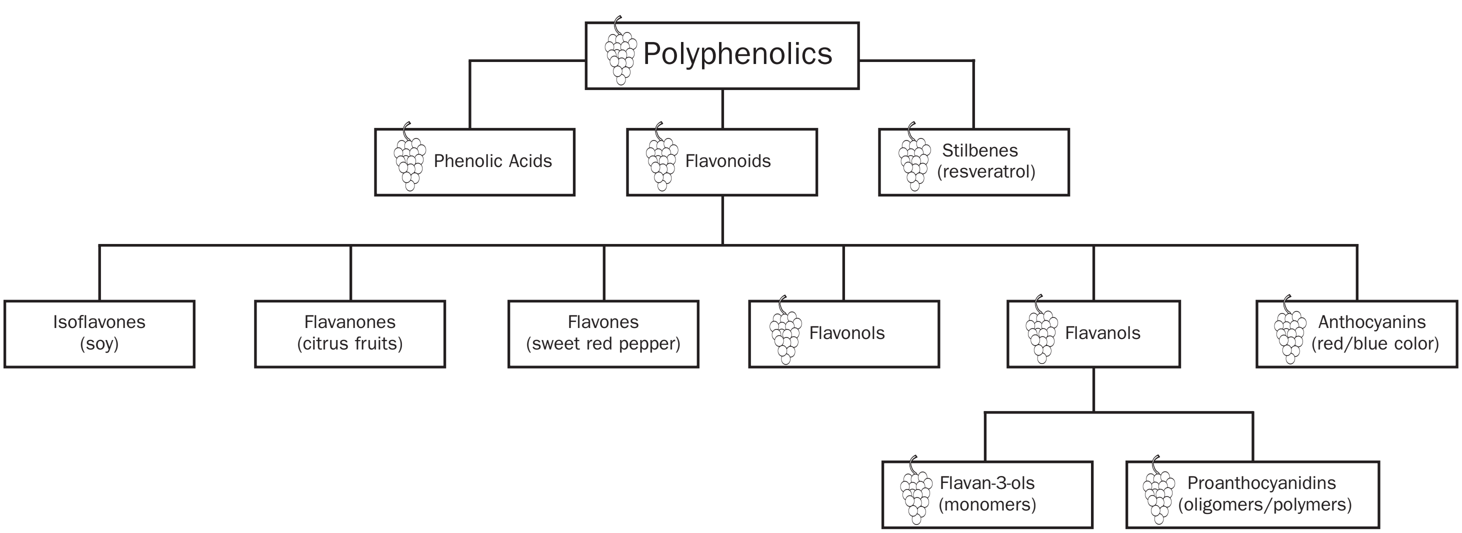
The Chemistry of Polyphenolics

Polyphenolic terms and classifications are often confused. A common error is that resveratrol, a compound to which many of the positive effects of red wine and Concord grape juice are incorrectly attributed, is often thought to be a flavonoid. While it is in the overall polyphenolic group, it is a stilbene — not a flavonoid.

At the same time, in this relatively new area of biochemistry, there are some legitimate differences of opinion as well. (Some chemists, for example, list proanthocyanidins as part of a larger class of polyphenolic tannins rather than a subgroup of flavonoids.) The chart below presents a consensus of the polyphenolic category.

Another misconception is that there is a direct link between the dark coloring found in Concord grape juice and its high antioxidant properties. Interestingly, while the anthocyanins — the polyphenols responsible for the dark purple coloring — contribute some antioxidant power, proanthocyanidins, which are colorless, actually provide most of the antioxidant power. White grape juice made with Niagara grapes, which contains no anthocyanins, has substantial antioxidant capacity from the abundance of proanthocyanidins, found primarily in the skin and seeds of the grapes. Other white grape juices, often made solely from Thompson seedless grapes or with very little Niagara grape content, lack these proanthocyanidins and have very little antioxidant capacity.

The boxes marked with a grape cluster (below) denote polyphenolics that are found in red wine and Concord grape juice.



Grape Cluster = Compounds found in Red Wine and Concord Grape Juice

Antioxidant Powerhouses — Common Foods and Juices

To establish an antioxidant capacity database, the USDA has undertaken the massive task of testing foods consumed by the U.S. population. This will take many years to complete. The table below is adapted from the USDA study published in late 2004,[8] which will serve as the foundation of the new antioxidant capacity database. The study used a method of measurement called Total Antioxidant Capacity, or TAC, to assign a numerical value for a food's antioxidant power. For purposes of comparison, we have inserted the antioxidant capacity values for various commonly consumed juices. The USDA study considered only a small sampling of juices, thus omitting those most commonly consumed. The antioxidant capacity values for the juices were computed from data prepared by an independent laboratory using the same ORAC methodology used by the USDA laboratory and are for comparison purposes only.

Total Antioxidant Capacity of Common Foods and Juices

Foods with TAC/serving of 2000 and higher "could be regarded as the best sources of total antioxidant capacity"[a]

Ranking	Foods Tested[a]	Antioxidant Capacity per serving[a]	Number of samples
1	Small Red Beans, dry (1/2 cup)	13,727	1
2	Wild Blueberries (1 cup)	13,427	1
3	(Red) Kidney Beans, dry (1/2 cup)	13,259	1
4	Pinto Beans, dry (1/2 cup)	11,864	3
5	Cultivated Blueberries (1 cup)	9,019	8
6	Cranberries (1 cup)	8,983	3
7	Artichokes, cooked (1 cup hearts)	7,904	2
8	Blackberries (1 cup)	7,701	4
9	Dried Plums (Prunes) (1/2 cup)	7,291	8
	Welch's 100% Grape Juice from Concord grapes (8 oz.)	6,582[b]	10
10	Raspberries (1 cup)	6,058	6
11	Strawberries (1 cup)	5,938	8
	100% Pomegranate Juice (8 oz.)	5,634[b]	3
12	Red Delicious/Granny Smith Apple (1 fruit)	5,600	8
13	Pecans (1 oz.)	5,095	8
14	Sweet Cherries (1 cup)	4,873	4
15	Black Plums (1 fruit)	4,844	2
16	Russet Potato, baked (1 potato)	4,649	4
17	Black Beans, dry (1/2 cup)	4,181	1
18	Plums (1 fruit)	4,118	8
19	Gala Apple (1 fruit)	3,903	3
20	Walnuts (1 oz.)	3,846	8
	100% Grapefruit Juice (8 oz.)	3,049	1
	Welch's 100% White Grape Juice from Niagara grapes (8 oz.)	2,849[b]	31
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	100% Orange Juice (8 oz.)	1,619[b]	19
	100% Tomato Juice (8 oz.)	1,527	1
	V8 Vegetable Juice (8 oz.)	1,329	1
	100% Apple Juice (8 oz.)	1,009[b]	32
	100% Juice – Other white grape (8 oz.)	895[b]	20
	100% Juice – White Cranberry Blend (8 oz.)	583[b]	4

[a]Wu X, Beecher GR, Holden JM, Haytowitz DB, Gebhardt SE and Prior RL. Lipophilic and hydrophilic antioxidant capacities of common foods in the United States. J Agric Food Chem. 2004. 52(12):4026-4037. (USDA study) Antioxidant Capacity reported is Total Antioxidant Capacity (TAC) = Lipophilic Oxygen Radical Absorbance Capacity ($L\text{-}ORAC_{FL}$) + Hydrophilic Oxygen Radical Absorbance Capacity ($H\text{-}ORAC_{FL}$). Values reported as average µmol TE/serving.

[b]Independent laboratory testing by Brunswick Laboratories; commissioned by Welch's – data as of 3/08/05.
Antioxidant Capacity reported is Hydrophilic Oxygen Radical Absorbance Capacity ($H\text{-}ORAC_{FL}$). Values reported as average µmol TE/serving.

Antioxidant Methodology

Relative antioxidant values used here have been determined using the oxygen radical absorbance capacity assay (ORAC) using fluorescein as the fluorescent probe in the assay.[16] This is an *in vitro* analysis that measures the ability of a substance to subdue oxygen free radicals and is not a direct measurement of what happens in the human body. While other *in vitro* antioxidant capacity assays exist (TEAC, TRAP, FRAP, DPPH) USDA scientists appear to have settled on ORAC as their accepted standard.[17,18] A recent enhancement of the ORAC assay methodology has allowed for the separate measurements of lipophilic and hydrophilic components of the same sample, providing a more complete antioxidant profile. As published in the USDA study, the combination of the lipophilic and hydrophilic values provides the total antioxidant capacity (TAC) value referenced in the previous table.[8]

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