It seems like whenever we open our emails, there is a new antioxidant “flavor of the week.” Indeed, over the past few decades the choices for nutraceutical antioxidants have increased exponentially, as have the number of articles written about those nutraceuticals. In fact, I’ve written a number of them in previous issues of Vitamin Retailer magazine for this same column. So when I was asked to write an article about antioxidants, I wondered what I could contribute to the existing tome of literature that hadn’t already been discussed ad infinitum. That’s when I decided that rather than focus as much on specific antioxidant nutraceuticals, I would discuss the relationship between ORAC and antioxidants—a relationship that has recently been called into question by the USDA. But first, let’s do a quick review of free radicals and antioxidants.

Free Radicals 101
Oxygen is an element indispensable for life. When cells use oxygen to generate energy, free radicals are created as a consequence of ATP (adenosine triphosphate) production by the mitochondria. These byproducts are generally reactive oxygen species (ROS) as well as reactive nitrogen species (RNS) that result from the cellular redox process. At high concentrations, they generate oxidative stress, a deleterious process that can damage all cell structures.¹ A body of evidence² suggests that most of the degenerative diseases that afflict humanity have their origin in free radical reactions. These diseases include cardiovascular and neurodegenerative diseases, cancer, inflammatory joint disease, asthma, diabetes, dementia, degenerative eye disease, autoimmune disorders and even aging itself.

Antioxidants 101
Conversely, endogenous (produced by the body) and exogenous (obtained from food or supplements) antioxidants act as free radical scavengers, preventing and repairing damages caused by ROS and RNS, and therefore can enhance immune defenses and lower the risk of degenerative diseases.³⁴⁵⁶⁷⁸ Fruits and vegetables serve as the primary dietary sources of exogenous antioxidants. Since different antioxidants have greater or lesser activity against different types of free radicals, it makes sense to obtain a broad range of antioxidants rather than focusing in on just one or two. This certainly helps makes the case for consuming a varied diet rich in fruits and vegetables. It also makes the case for utilizing a range of nutraceutical antioxidants. Furthermore, some nutraceuticals have significantly more antioxidant activity than others, as measured by ORAC testing.

ORAC Testing
Oxygen radical absorbance capacity (ORAC) tests quantify antioxidants in a material. ORAC testing measures antioxidant scavenging activity against oxygen radicals, and was jointly developed by Brunswick Laboratories and the Jean Mayer USDA Human Nutrition Research Center at Tufts University. ORAC testing has been scientifically validated in published research⁹¹⁰¹¹¹² as an accurate method for measuring antioxidant

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capacity of foods and nutraceuticals. Until recently (more on this later) the USDA provided a database of the ORAC value of selected foods, primarily fruits and vegetables, which was a great tool to help people plan diets with higher levels of antioxidants. Indeed, this seemed to be the purpose of the database in reading its introduction:

Although the human body has developed a number of systems to eliminate free radicals such as reactive oxygen species from the body, it is not 100 percent efficient. Diets rich in fruits and vegetables are considered to be an excellent source of antioxidants.

**ORAC 5.0 Testing**
Whereas the original ORAC analysis only tested the antioxidant capacity of the peroxyl radical, the newer oxygen radical absorbance capacity for food and nutrition, ORAC 5.0, consists of five types of assays that evaluate the antioxidant capacity of a material against five primary reactive oxygen species found in humans: peroxyl radical, hydroxyl radical, superoxide anion, singlet oxygen, and peroxynitrite. While the peroxyl radical is the most abundant free radical in the human body, other types also contribute toward oxidative damage. The hydroxyl radical is highly reactive and cannot be eliminated by our endogenous enzymes (such as SOD and glutathione). It can damage virtually all types of macromolecules: carbohydrates, nucleic acids, lipids and amino acids. In the skin, hydroxyl radicals are created by UV exposure. Peroxynitrite radicals are reactive nitrogen species that are particularly harmful to proteins. They have been implicated in the development of certain cancers, hepatitis, and chronic inflammation. In the skin, peroxynitrate contributes to the breakdown of vitamin proteins, such as collagen. In the skin, singlet oxygen is generated by UV. In vivo, it is linked to the oxidation of LDL cholesterol and cardiovascular disease; singlet oxygen is highly unstable and durable. Superoxide anions are precursors of all other reactive oxygen species. It is highly toxic and contributes to lipid and DNA damage. Antioxidants that scavenge superoxide anions also help prevent the formation of radicals such as hydrogen peroxide and hydroxyl. Superoxide anions have been linked to hypertension and cardiovascular damage. Then, I listed their common serving size, as provided in the USDA’s food database. Next, I used the USDA’s ORAC database to calculate the ORAC units for each serving size of each the 20 fruits and vegetables. Finally, I added the total ORAC units for all 20 servings of fruit, divided that by 20 and determined an average value of 2,186 ORAC units for an average serving of fruit. I did the same for vegetables, and determined an average value of 955 ORAC units for an average serving of vegetables. When combined together, I obtained an average value of 1,570 ORAC units for an average serving of fruits and vegetables.

**ORAC & ORAC 5.0 Values for Selected Nutraceuticals**
Although this article is not about specific antioxidant nutraceuticals, I thought it might be interesting to present the ORAC and ORAC 5.0 values for a few select nutraceuticals (see chart above).

**Nutraceutical Antioxidant/ORAC Equivalency to Fruits and Vegetables**
While the consumption of nutraceutical antioxidants in no way is a substitute for eating fruits and vegetables, it is a way to help increase the overall antioxidant value of the diet. In fact, by considering the ORAC value of nutraceuticals, I figured it would be possible to establish the antioxidant equivalency between them and a given number of servings of fruits and/or vegetables—although this was easier said than done.

In determining the basis for antioxidant (ORAC) equivalency, I scoured the scientific literature for an established estimate for the average number of ORAC units from fruits and vegetables consumed, but could not find an established number. Consequently, I took a different approach.

First, I identified the 20 most frequently consumed fruit and vegetables in the U.S., using information provided in the Code of Federal Regulations. Then, I listed their common serving size, as provided in the USDA’s food database.

<table>
<thead>
<tr>
<th>Nutraceutical</th>
<th>ORAC value (μmol TE/g)*</th>
<th>ORAC 5.0™ (μmol TE/g)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aloe [herb, dry powder]</td>
<td>2,737</td>
<td>135,647</td>
</tr>
<tr>
<td>Bilberry Extract [65% total anthocyanosides]</td>
<td>5,648</td>
<td>53,391</td>
</tr>
<tr>
<td>Citrus Bioflavonoids [Mostly hesperidin (flavonol glycoside), approx 25%]</td>
<td>541</td>
<td>1,950</td>
</tr>
<tr>
<td>Curcumin [Pure material (98%+)]</td>
<td>6,211</td>
<td>82,922</td>
</tr>
<tr>
<td>Ginkgo Extract [24% flavonol glycosides]</td>
<td>4,222</td>
<td>22,884</td>
</tr>
<tr>
<td>Grape Seed Extract</td>
<td>11,247</td>
<td>95,561</td>
</tr>
<tr>
<td>Green Tea Extract</td>
<td>3,996</td>
<td>34,819</td>
</tr>
</tbody>
</table>

*All values are per gram of nutraceutical material.

** ORAC 5.0 values are always higher because it measures antioxidant effectiveness against five types of free radicals.
signs of sun-damage and premature aging of the skin. Those receiving 10 mg of ChOSA daily experienced a 30 percent improvement in shallow, fine lines and 55 percent increased skin elasticity, and a significant reduction in brittle nails and hair.

The Link Between Wrinkles and Bone Health
Changes in skin collagen with age correspond with changes in collagen in bone. Hence, evidence of decreased skin collagen (e.g., lots of wrinkles) is a clear indication of a lack of bone collagen and a risk for osteoporosis. ChOSA has also shown benefits in promoting bone health through increasing the manufacture of collagen. In a very detailed double-blind study in postmenopausal women with low bone density, ChOSA was able to increase the collagen content of the bone by 22 percent and increase bone density by 2 percent within the first year of use. The recommended dosage is 6-10 mg daily.

Flavonoids are Critical
The flavonoids are a group of plant pigments that exert many beneficial effects in supporting healthy collagen. In general, flavonoids produce an antioxidant activity that is more potent and effective against a broader range of oxidants than the traditional antioxidant nutrients like vitamins C and E, beta-carotene, selenium and zinc. This effect goes a long way in protecting collagen structures from damage. Especially beneficial to collagen structures are the blue or purple pigments—the anthocyanidins and PCOs (short for proanthocyanidin oligomers)—that are found in grapes, blueberries, and many other foods. These flavonoids can also be found in pine bark and grape seed extracts. Anthocyanidins, PCOs and other flavonoids affect collagen metabolism in many ways:
- They have the unique ability to actually crosslink collagen fibers resulting in reinforcement of the natural crosslinking of collagen that forms the so-called collagen matrix of connective tissue (ground substance, cartilage, tendon, etc.).
- They prevent free radical damage with their potent antioxidant and free radical scavenging action.
- They inhibit destruction to collagen structures by enzymes secreted by our own white blood cells during inflammation.
- They prevent the release and synthesis of compounds that promote inflammation such as histamine.

To ensure sufficient levels of these beneficial flavonoids increase your intake of richly colored berries and other fruit. It is also a good idea to supplement your diet with a PCO extract such as grape seed or pine bark at a dosage of 50 to 150 mg daily for general support. VR

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accurate to state, “One serving of nutraceutical X is the equivalent to five servings of fruits and vegetables,” but it would be accurate to state, “One serving of nutraceutical X is the antioxidant (or ORAC) equivalent to five servings of fruits and vegetables.”

USDA’s Removal of ORAC Database
Recently the USDA removed their ORAC database from their website. They had a few reasons for doing this. Following are two of the main stated reasons, as well as responses by Ronald L. Prior, PhD, who was senior researcher at the Agricultural Research Service of the USDA for more than 30 years.

USDA: “ORAC values are routinely misused by food and dietary supplement manufacturing companies to promote their products and by consumers to guide their food and dietary supplement choices.”

Prior: “It is unfortunate but true that numbers obtained from ORAC analysis have sometimes been misused, but that does not necessarily mean that the information is not useful if used appropriately.”

USDA: “There is no evidence that the beneficial effects of polyphenol-rich foods can be attributed to the antioxidant properties of these foods.”

Prior: “[These statements] are not consistent with the scientific evidence. A recent study just released concluded that ‘Using the ORAC database, after adjusting for major covariates, we found decreased risks for the highest tertile of total phenolic intake compared with the lowest, ... suggesting that total phenolic consumption may decrease endometrial cancer risk.’ Another recent publication reported that: ‘Adherence to a Mediterranean-type diet, with emphasis on an increase in foods rich in antioxidants and close dietetic supervision, can increase total dietary antioxidant intake and plasma TAC in patients with abdominal obesity.’”

Conclusion
In short, whatever the USDA’s reasons for removing their database, research clearly shows that the consumption of a broad range of antioxidants has significant benefits to offer for human health. Furthermore, ORAC and especially ORAC 5.0, are important tools for assessing the antioxidant value of nutraceuticals and, by implication, the potential value to human health. VR

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