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## Buyer's Guide to Chondroitin Sulfate

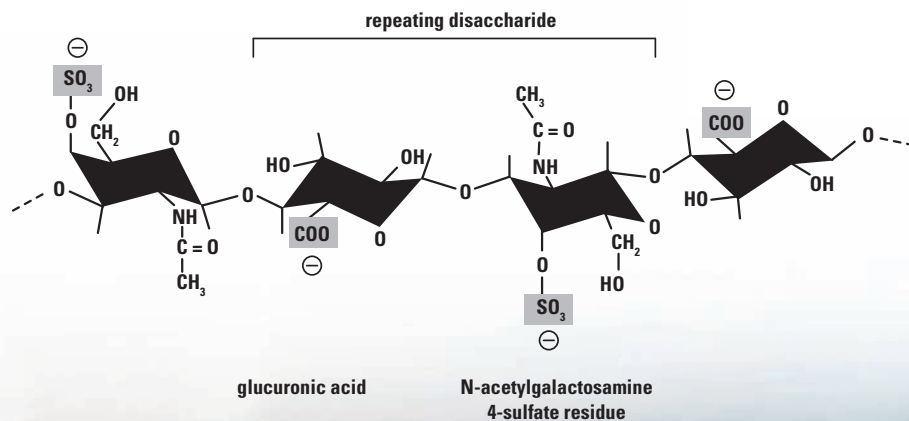
**Chondroitin sulfate is well known in the nutrition and health industry, consistently ranking among the top five most popular ingredients.**

However, just because an ingredient is well known doesn't mean it is a commodity in which all ingredients are created equal. While most people feel they understand chondroitin sulfate, AIDP has found that buyers and scientists alike continue to be confused because of misinformation, changes in testing methodologies and unscrupulous ingredient manufacturers. Dr. Jennifer Gu, AIDP's director of research and development, has compiled this guide to help you be a savvy consumer of chondroitin sulfate.

### What Is Chondroitin Sulfate?

Molecularly, chondroitin sulfate is a glycosaminoglycan (GAG) widely found in the animal kingdom as part of connective and structural tissues. It is an important component of cartilage that provides resistance to compression. Chondroitin sulfate is composed of a chain of alternating sugars: N-acetylgalactosamine (GalNAc) and glucuronic acid, usually attached to proteins as part of a proteoglycan (Figure 1).

Figure 1: Structure of Chondroitin Sulfate



## What Are Different Types of Chondroitin Sulfate?

Chondroitin sulfate can be separated into A, C, D and E identifications (see Table 1), based on the quantity of sulfation on its sugar residues.

Table 1

Letter identification	Site of sulfation	Systematic name
Chondroitin sulfate A	carbon 4 of the N-acetylgalactosamine (GalNAc) sugar	chondroitin-4-sulfate
Chondroitin sulfate C	carbon 6 of the GalNAc sugar	chondroitin-6-sulfate
Chondroitin sulfate D	carbon 2 of the glucuronic acid and 6 of the GalNAc sugar	chondroitin-2,6-sulfate
Chondroitin sulfate E	carbons 4 and 6 of the GalNAc sugar	chondroitin-4,6-sulfate

Calcium/potassium chondroitin sulfate is a newly introduced chondroitin salt that reduces sodium while introducing calcium (potassium) into the molecule. This helps formulators and marketers meet their customers' demands for low- or no-sodium formulations.

Beverage-grade chondroitin sulfate is specially designed to go into suspension. Since chondroitin sulfate is derived from animals, the variation in quality can be vast, creating significant differences in the final product. When formulators use a quality, beverage-grade material, the resulting ingredient more quickly dissolves into the beverage, creating less precipitation and more clarity. In addition, using beverage-grade material creates a more favorable flavor profile than using lower-quality ingredients.

## Methods and Problems Associated with Chondroitin Sulfate Testing

Chondroitin sulfate is a complex natural product that continues to create challenges for customers looking for high-quality and pure ingredients.


### Common but unspecific testing methods include:

- Carbazole-colorimetric: This method relies on the color reaction of glucuronic acids with carbazole. It is a nonspecific testing, and any material containing glucuronic acid, such as pectin, will produce a similar color reaction.
- Size-exclusive chromatography: This method is based on the gel filtration technique of separating molecules according to their size. Large molecules are eluted from the column first; the smaller molecules are eluted later. It is also nonspecific testing, since any material that includes similar GAGs, or large proteins/collagens with a molecular weight similar to that of chondroitin sulfate will be eluted from the column at the same time as chondroitin sulfate.
- CPC-titration: This method is dependent on the formation of turbidity due to the reaction of CPC (cetylpyridinium chloride) with organic anions. A titrator then measures the turbidity. This is the most commonly used method but has the same limited specificity as all other mucopolysaccharides or even some proteins and can have a similar turbidity reaction with CPC as chondroitin sulfate.
- RP-HPLC (reverse-phase HPLC): This method separates analytes based on a number of factors, including polarity, size and pH. Typically, chondroitin sulfate used in nutritional products is composed of polymers with variable lengths; thus, the profiles used in RP-HPLC analysis would have to include multiple peaks, making it difficult to count all the possible peaks or to distinguish peaks that contain analytes but are not chondroitin sulfate. Chondroitin sulfate from various manufacturers may have different molecular weights that would lead to conflicting test results, as well.

The lack of specificity of these testing methods can lead to possible contaminants and adulterants, due to their inability to distinguish between chondroitin sulfate and such ingredients as carrageenan, dextran sulfate, protein or other related GAGs.

### Industry-Preferred Test Method

Enzymatic HPLC has been adopted by AOAC as the preferred test method for chondroitin sulfate. This method is still relatively new, and only a few suppliers are offering material that has been tested using Enzymatic HPLC. In the past seven years, AIDP has been leading the way by offering Enzymatic HPLC-tested chondroitin sulfate of the highest quality and purity.

 **Enzymatic HPLC:** This method relies on the specific enzymatic activity of chondroitinase AC. Chondroitin sulfate is hydrolyzed into unsaturated disaccharides, which can be separated by HPLC and detected by UV at 240 nm. This method involves more steps, takes longer and costs more than other testing methods, but it is both accurate and specific. There is virtually no interference due to the specific and selective enzymatic activities.

The Enzymatic HPLC method is highly selective, accurate and repeatable. It is a challenge for most suppliers to meet the rigorous quality standards for purity and consistency. AIDP is proud to be one of very few suppliers able to meet these requirements, providing some of the highest quality chondroitin sulfate on the market.

### Buyer Beware: 85 % CPC vs. 90 %+ CPC

**In addition to understanding the different testing methods and their limitations, buyers should beware of diluted materials.**

The experts at AIDP highly recommend that formulators discontinue the use of 85 percent (by CPC) chondroitin sulfate material. AIDP advocates this change due to advancements in technology that make the 85 percent material unnecessary. One of the many processes involved in the production of chondroitin sulfate includes filtration; this step allows for material of the highest purity. Ten years ago, it took two filtration steps to reach 90 percent purity, but because of technological advancements, 90 percent purity can now be achieved with just one filtration step, making 90 percent the lowest grade of purity possible today. However, the legacy of 85 percent material persists. This means that 90 percent material is being diluted with lower-grade material. Most highly regarded and reputable factories in this space no longer offer this lower-quality product.

### Factory Facts

There are now hundreds of factories making chondroitin sulfate in all different qualities and purities — from GMP-certified manufacturers to small “mom and pop” factories. Buyers should be aware that there is a thriving business for very small manufacturers that do not sell directly to the U.S. consumer, but instead sell their low-quality material to larger companies that blend and package the material for sale to third-party export companies. These companies often don’t use basic good hygiene practices, quality control systems, paperwork or even wastewater treatment. Given price pressure in the market, these factories and exporters are the most likely to mix in adulterants that will fool the less-specific test methods discussed earlier. While their product is particularly inexpensive, its quality is not suitable for the U.S. market and should be reviewed with caution.

AIDP’s extensive knowledge of the science behind chondroitin sulfate, 15 years of direct experience sourcing and selling chondroitin sulfate, direct partnership with chondroitin sulfate manufacturers and personal inspection of the chondroitin sulfate raw material supply chains makes AIDP the trusted source for all of your chondroitin sulfate needs.

**To learn more about chondroitin sulfate or AIDP’s complete product listing, please visit our website at [www.aidp.com](http://www.aidp.com). You may also contact us directly at [CustomerCare@aidp.com](mailto:CustomerCare@aidp.com), or toll-free at 866/262-6699.**

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