by Ryan Zadow

# THE REAL DIRT ON Humic Substances

Humic substances (HS) are the least understood component of soil, yet one of the most important materials found in a healthy balanced soil system. While much has been discovered over the last 40 years, scientists who have experience working with HS realize that the more we know the more there is to learn about these versatile materials. Over the past 15 years hydroponic growers have also proven that soluble carbon, in particular humic substances, are a limiting factor in aqueous based cultures and soilless media. Today most gardeners are familiar with HS on some level and have seen the benefits, yet many are still scratching their heads when it comes to understanding the labelling. The focus of this article is not to re-address the qualities and benefits of HS. Instead it is to explore the confusion surrounding analysis, registration issues and misconceptions about humic and fulvic products in general.

Currently, there is considerable buzz about humic and fulvic acid, which is no surprise to people who have experience using a high quality product. But confusion due to product labelling has many people questioning the humic substance industry. The way a product is described, guaranteed and marketed is largely governed by state agricultural regulatory departments. Unfortunately, there is no "standardized" analytical method for quantification, and accepted labelling practices often vary greatly from state to state and province to province in Canada. For example, in California and Oregon the term fulvic acid is not allowed to be used on any product label. Instead these state agencies consider fulvic and humic acid the same substance and require that only humic acid be used on labels. This creates analytical challenges and mass confusion for those products that are fulvic isolates, having no measurable humic acid in them. This might help to explain why some products will guarantee a product as 0.01 per cent and others may be claiming eight

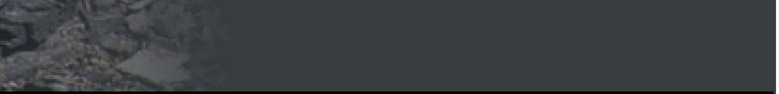


Photo courtesy of Mesa Verde Resources. Humic substances start out as raw ore; they are insoluble and hard to break down. The way a product is made soluble can indirectly influence the testing method used to guarantee it.

per cent. To help sort these issues out further we will review some of the commonly used, commercially available analytical methods as well as their advantages and disadvantages. First, to better understand the focus of this article we must define HS and the fractions thereof.

For the sake of this article we will use definitions without too many details:

Organic matter - All the non-living material of biological origin in a soil system. These are found in various stages of decay.

Humus - Stable portions of organic matter that are well "rotted" but not yet having gone through the humification process.

Humic substances (HS) - This is a broad heading that encompasses all fractions of the total material and can be defined as organic matter that is very stable; has been through the humification process; and is more resistant to microbial degradation. They are the end result of microbial degradation of once living organic material. Also often referred to as humate even though this is a bit of a misnomer.

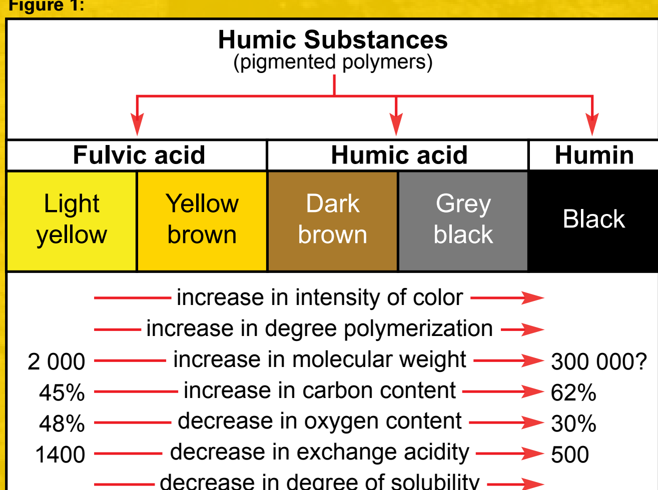
Humic acids - The fraction of HS only made soluble under alkaline (high pH) conditions and which is insoluble in dilute acid environments. They have a high molecular weight and are brown to black in colour.

Fulvic acids - The fraction of HS that is soluble in water under all pH conditions. They remain in solution after removal of humic acid by acidification. Fulvic acids are golden to yellow-orange in colour.

Humin - The fraction of humic substances that is not soluble in water at any pH value. Humins are black in colour.

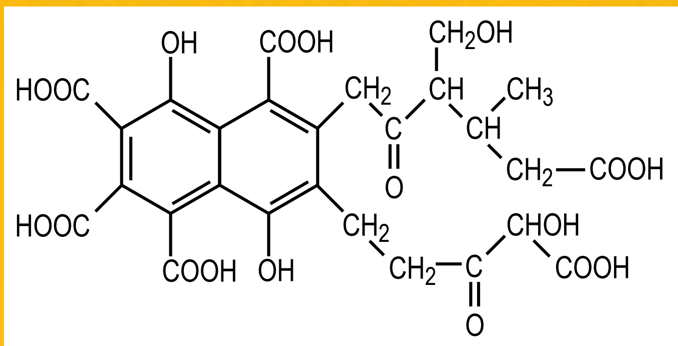
Humate and fulvate - The salts of humic and fulvic acid respectively. When HS are extracted using chemical reagents this salt forms are created.

**Figure 1:**




Chemical properties of Humic substances. *(Stevenson 1982)*

**Figure 2:**



Model structure of fulvic acid. (by Buffle)

## A Closer Look

We can gain more insight from the following diagrams.

Figure one shows how molecular weight can be directly related to the colour of an extraction or product. Molecular weight is correlated to the size of a molecule. The higher the molecular weight the larger the molecule's structure is. While some may find this a tedious detail, it is an important fact because humic acids are actually too large to be absorbed into a plant's roots or leaves, while fulvic acid is small enough to be easily assimilated. This is why humic acids are more closely associated with soil conditioning properties and feeding soil microbes. This is in contrast to the smaller fulvic acid, which is better for increasing nutrient efficiency and uptake, lateral root growth, building plant immunity and also stimulating microbes. Figure two provides us a "flavour" of what a fulvic acid molecule is like. It is important to note that HS are analogous to snow flakes because they are mixtures of similar types of molecules but not all are alike. This is due to the fact that they were created from a variety of different plants and other once living things. Figure three is a proposed humic acid molecule. These diagrams make it easier to envision the idea of molecular size and how it influences humic and fulvic's functions in plant and soil systems.

Now that we have established that size dictates certain desirable properties and that there is a direct correlation between colour and size, it would make sense to quantify both or either of these two fractions when labelling a commercially available product. In some instances a soil grower may want a higher humic content and be looking to improve soil characteristics or feed microbes; in other instances a hydroponic grower may prefer just the fulvic fraction for the biological benefits or as a foliar spray.

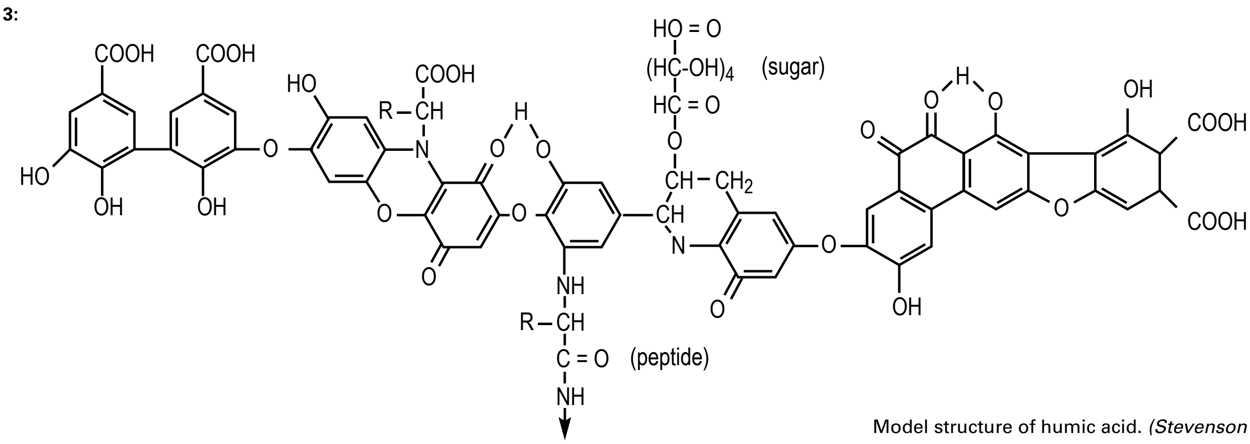
Compounding these regulatory issues is the fact that there are several analytical methods being used and/or accepted by different states and in Canada. These can produce results that vary widely. To better understand how this occurs we must review the methods of commonly used analytical tests. The following are testing methods are universal.

## Colourimetric

In this test the humic acid is exposed to light and the measurement comes from a reading of how much light is

Humic sources vary widely. Here a layer of raw ore is protected by six metres of sandstone preventing the fulvic fraction from rinsing away. Photo courtesy of Mesa Verde Resources.

**Figure 3:**



Model structure of humic acid. *(Stevenson 1982)*

**"Knowing the percentages of the humic acid as well as fulvic acid is an advantage, considering that structure and physical characteristics determines their role."**


absorbed by the sample. This value is compared to the value of a sample that is purchased from Sigma-Aldrich.

**Advantages**: Quick and easy making it possible to run many samples through the machine. This makes it cost effective for commercial use, which has led it to be the most widely used test. A&L labs use a slight modification of this method, which is widely used by many manufacturers.

**Disadvantages**: Gives total humic and fulvic but does not give individual values for each (aka the total alkali extractables). The Sigma-Aldrich sample (standard) used comes from a unique deposit in Germany that can be substantially different in composition as compared to some of the materials it is being used to test against. (This information was obtained through personal communication with Sigma-Aldrich). Currently there is work being done to improve this method.

Please note the following three methods measure the target materials by drying and weighing the material for the respective fraction.

**CDFA**

Known as the California method as it was developed by their state department of agriculture. This method separates the humic and the fulvic. It then discards the fulvic solution and measure all the remaining material, which includes the inorganic ash in with the humic.

Humic substances can be formed from a variety of starting materials and environmental conditions, resulting in varying structures.

**Advantages**: This is the only method that the California and Oregon departments of agriculture will accept when registering a product.

**Disadvantages**: Only the humic is measured while the fulvic is thrown away, and no purification steps are performed to remove the ash giving way to inaccuracies in the measurement.

### USGS/IHSS (aka the classical method)

This method is used and endorsed by both the United States Geological Service and the International Humic Substance Society. This method separates and measures both the humic and fulvic fractions while also going through rigorous purification steps to remove all insolubles, salt reagents and other materials that are not humic or fulvic.

**Advantages**: Quantifies both humic and fulvic with their individual values in their purified state. Highly accurate.

**Disadvantages**: More time consuming and costly test. (This is the method that produces per cent for fulvic in the typical range of 0.01-0.02 per cent)

### Verploegh and Brandvold (aka V&B method)

Named for the duo of scientists who introduced the test that is based on the classical method. This is the same as the classical test except that it goes through almost no purification steps.

**Advantages**: Measures both humic and fulvic. Quick and easy test to perform. Removes insoluble matter.

**Disadvantages**: Does not go through purification of the chemical reagents used to separate the humic and fulvic acids. This results in massive inaccuracies of the fulvic measurement because the majority of the reagents are present in solution with the fulvic fraction along with any amino acids, proteins, lipids and carbohydrates. (This is the method that produces per cent for fulvic in the typical range of six to eight per cent).

No matter what method is used the fact remains that until a single test is made standard and used by all registration agencies the confusion will continue through the marketplace. It is clear that knowing the percentages of the humic acid as well as fulvic acid is an advantage, considering that structure and physical characteristics determines their role. The most useful analytical method is one that allows people to see the unadulterated percentages of both the humic and fulvic acid contents of a particular product. Please keep in mind that although having the concentration of these fractions is helpful, it is only one parameter that helps us understand/judge the quality of a raw material or product. Because these substances can be formed from many varying starting materials and environmental conditions the structures produced will also vary. This is not taken into account with just a number. Other factors such as how a deposit is formed over time and how the humic and fulvic are extracted will also have a large influence on material or product viability. MY

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