AN IN-DEPTH LOOK AT HUMIC ACID & FULVIC ACID

Introduction

In order to understand what Humic/Fulvic Minerals & Electrolyes™ is and how it works, it is necessary to define what is meant by humic acid and fulvic acid and to ascertain where their origins lie. The discussion below is based on current scientific theory as it relates to the soil sciences. It recognizes that although absolute precision is impossible because of the complex and adaptable nature of humic acid and fulvic acid, certain fundamental characteristics can be delineated upon which all variables rest. With that in mind, this discussion looks at where the current theory stands. Once this basis has been established, the discussion will turn to the use of humic acid and fulvic acid in human biology and the specific make up of Humic/Fulvic Minerals & Electrolyes™.

Before delving into humic acid and fulvic acid, it is necessary to define the word organic because it can have different meanings in different settings which can be confusing. In food production or supplement production, "organic" means produced or involving production without the use of chemical fertilizers, pesticides, or other artificial agents. The supplier of the humic acid and fulvic acid in Humic/Fulvic Minerals & Electrolyes™ uses organic practices and is not only USDA organic certified, but also certified under the Canadian Organic Foods Program, The European Union Organic Foods Program, and the Japanese Ministry of Agriculture (Organic Foods program). In this case the word organic refers to the standards by which something is made or processed.

In chemistry, organic describes “a branch of chemistry that is concerned with carbon and especially carbon compounds which are found in living things.” (Merriam-Webster Online Dictionary, 2019) In this case the word is used to describe the element of main importance, namely carbon, and its relationship to life.

“Organic matter is defined as a grouping of carbon containing compounds which have originated from living beings and deposited on or within the earth's structural components.” (Pettit, 2004). In soil, organic matter is formed by the decomposition of any living thing that has died and been deposited in or on the soil, including both plants and animals.

Humus is a specific type of organic matter that is “a brown to black complex variable of carbon containing compounds” that is separate from known substances such as “carbohydrates (a major fraction of soil carbon), fats, waxes, alkanes, peptides, amino acids, proteins, lipids and organic acids” (Pettit, 2004). Put more simply, humus can be defined as the organic compounds in soil that cannot be classified as any other chemical class of compounds (Gaffney et al., 1996). Humus is part of the life and death cycle and plays an important role in recycling the building blocks of life.

Humus is formed by three main components called humic substances. These humic substances are humin, humic acid, and fulvic acid. These three components are differentiated most clearly by their solvation rates (solubility) at different pH values (Stevenson, 1994; Gaffney et al., 1996).

Humin is the insoluble part of the soil and makes up 50% of the organic matter in humus. In an aqueous solution, humin is the least soluble or most insoluble component at any pH value. This means humin will not dissolve in water. The main reason for this poor solubility in an aqueous solution is that humin is tightly bonded to inorganic soil colloids (Cloos et al., 1981; Rice, 2001). Humin is partially soluble in an alkali solution but the relationship between the soluble and insoluble fractions remains unknown (Li et al., 2015).

Once the humin is removed from the humic substance solution, humic acid (HA) and fulvic acid (FA) remain. Under normal pH both HA and FA remain soluble in an aqueous solution. When the solution is acidified, the HA will precipitate (flocculate or become insoluble) but the FA will remain soluble. The FA will remain soluble independent of pH and ionic strength (Gaffney et al., 1996; Pettit, 2004).

Humic Substances in Soil

Humic substances in soil play many beneficial roles. These include:

1) **Energy source for beneficial soil organisms:** Humic substances provide many of the energy requirements for soil microorganisms and soil animals. These organisms do not have the ability to utilize photosynthesis as plants do so the sun cannot meet their energy needs. The energy found in humic substances is stored in the carbon bonds found within the various molecules and is utilized in many metabolic reactions by these organisms. These beneficial soil organisms include algae, yeasts, bacteria, fungi nematodes, mycorrhizae, and small animals (Pettit, 2004).
2) **Increasing the water holding capacity:** Humic substances act as water sponges because of their large surface area and internal electrical charges. This is one of their most critical roles in supporting plant life (Pettit, 2004).
3) **Making soil fertile by forming colloidal complexes of humus-clay:** As the humic substances combine with the mineral fraction of the soil, colloidal complexes of humus-clay and humus silt aggregates are formed. The new soil structure allows for gaseous interchange with the atmosphere and for greater water infiltration (Pettit, 2004).
4) **Degrading or inactivating toxic substances:** HA has an affinity for heavy metals, organic pesticides, and man-made hydrocarbons that have aromatic or hydrophobic (water-insoluble) chemical structures (Encyclopedia Britannica online, 2019). Soil humic substances function to either stabilize or assist in the degradation of toxic substances such as: nicotine, aflatoxins, antibiotics, and most organic pesticides (Pettit, 2004).
5) **Buffering (neutralizing) the soil pH and liberating carbon dioxide:** Both acidic and alkaline soils are neutralized by humic substances. This releases many trace elements formerly bound in the soil by the unbalanced pH and they become available to the plant roots. Humic substances also liberate carbon dioxide from calcium carbonates present within the soil. Released carbon dioxide may be utilized by plants or it may form carbonic acids. The carbonic acids act on soil minerals to release plant nutrients (Pettit, 2004).
6) **Stabilizing and inactivating soil enzymes:** Pathogens in the soil release enzymes to begin weakening the plant. Humic substances stabilize these enzymes and stop this activity (Pettit, 2004).
7) **Stabilizing soil temperature and water evaporation rate:** The insulating properties and the water holding capacity of humic substances work together to stabilize the soil temperature and reduce evaporation. This is especially true in periods of rapid climatic changes (Pettit, 2004).
8) **Dissolving and binding trace minerals:** Both HA and FA allow the soil to inhibit the crystallization of mineral elements by combining with them which will be discussed in-depth in the Humic Acid/Fulvic Acid and Metals (Minerals) section below. This stops the formation of insoluble precipitates such as metal carbonates, oxides, and sulfides. This process is part of soil genesis in which transition mineral elements form metal organic clay complexes (Pettit, 2004).

Humic Acid and Fulvic Acid

As stated in the introduction, although absolute precision is impossible because of the complex and adaptable nature of HA and FA, certain fundamental characteristics can be delineated upon which all variables rest. The process by which HA and FA are formed is an extremely adaptable process. The exact nature of any HA sample or FA sample is based on the many factors that produced it and that act as variables. These include but are not limited to, the minerals present in the area where the HA and FA were formed, the age of the samples, the environmental conditions under which they were formed (temperature, humidity, etc.), the biological sources that are decomposing or were decomposed, and geological factors present (altitude, type of land, type of water, etc.). Even though all of these variables produce distinct variations of HA and FA, there are certain characteristics that are shared by all HA and FA regardless of the circumstances under which they were produced. These overall similarities are more pronounced than the differences between individual samples (Gaffney et al., 1996). Therefore, the fundamental framework of both HA and FA can be explained.

Humification

The early study of humus and humic substances concluded that polymers were being formed during humification which accounted for the complex molecules found. Currently there are three theories that explain humification. These are:

1) **Lignin Theory:** This theory is the oldest maintains the lignin found in decomposing plants is used and modified by microorganisms which yield first HA then FA (Schepetkin et al., 2002 citing Waksman, 1938).
2) **Polyphenol Theory:** Phenolic aldehydes and acids released during microbiological attack of decaying plant matter, undergo enzymatic conversion to quinones. These then polymerize in the presence or absence of amino compounds to form dark-colored polymers (Schepetkin et al., 2002 citing Kononova, 1966).
3) **Sugar–amine Condensation Theory: "**Reduced sugars and amino acids formed as byproducts of microbial metabolism undergo nonenzymatic polymerization to form brown nitrogenous polymers" (Schepetkin et al., 2002 citing Stevenson, 1994).

Characteristics

According to these polymer theories, the main differences between HA and FA are molecular weight, the number of carbon, hydrogen, oxygen, nitrogen, and sulfur atoms each generally possesses, the ratios between these atoms, the level of acidity/reactivity of each species, and solubility.

1) **Molecular weight:** HA is considered to have a high molecular weight (HMW) whereas FA is considered to have a low molecular weight (LMW). HA has a molecular weight range from approximately 10,000 to 100,000. FA has a molecular weight range from approximately 1,000 to 10,000 (Pettit, 2004).
2) **Number of atoms:** HA has an average chemical formula of $C_{187}H_{186}O_{89}N_9S_1$ while FA has an average chemical formula of $C_{135}H_{182}O_{95}N_5S_2$ (Encyclopedia Britannica online, 2019). **"**The range of the elemental composition of humic materials is relatively narrow, being approximately 40-60% carbon, 30-50% oxygen, 4-5% hydrogen, 1-4% nitrogen, 1-

2% sulfur, and 0-0.3% phosphorus." (Gaffney et al., 1996 citing Maccarthy et al., 1989) "Humic acids contain more hydrogen, carbon, nitrogen, and sulfur and less oxygen than fulvic acids." (Gaffney et al., 1996 citing Schnitzer et al., 1972)

3) **Atomic ratios:** HA has a carbon/hydrogen ratio that is basically 1:1 which indicates a high degree of aromatic character, the presence of benzene (carbon) rings. FA has a carbon/hydrogen ratio of less than 1:1 which indicates less aromatic character. HA has a carbon/oxygen ratio that is far lower than FA which means HA is less acidic in nature than FA. In fact, FA has twice the concentration of oxygen as HA (Pettit, 2004; Encyclopedia Britannica online, 2019).
4) **Acidity/Reactivity:** The main functional groups in both HA and FA are phenolic & carboxyl groups which contribute to the surface charge and reactivity of each (Stevenson, 1994). FA has more carboxyl (COOH) and hydroxyl (COH) groups than HA and is therefore more chemically reactive (Pettit, 2004; Encyclopedia Britannica online, 2019).
5) **Solubility:** HA will precipitate at a pH below 2 whereas FA remains soluble at all pH levels (Pettit, 2004).

Bonding

The polymer theories account for the strong bonds that are present in both HA and FA between molecules. However, these theories run into a problem with the low molecular weight of FA and the different characteristics it displays than any other polymer. They are therefore forced to accommodate these facts with a unique species of polymers found in FA only (Yamauchi et al., 1984).

At the turn of the 21st century a new school of thought proposed that instead of the complex molecules being polymers, they were in fact supramolecular associations of self-assembling heterogeneous and relatively small molecules (Piccolo, 2002; Piccolo et al., 2018). The benefit of the supramolecular associations theory is the flexibility it provides in the bonding and arrangement of the molecules present in both HA and FA.

Furthermore, the supramolecular associations theory can account for the stronger bonding found in both HA and FA than the theory would normally produce by the fact that metals are present in both. These metals (minerals) can act as bridges among molecules, stabilizing the tridimensional arrangement of humic superstructures with strong intermolecular electrostatic bonds (Piccolo et al, 2018 citing Aquino et al., 2011 and Kalinichev et al., 2011 and Orsi, 2014).

The supramolecular associations theory defines HA and FA in these terms:

> Humic acids are made by associations of predominantly hydrophobic compounds (polymethylenic chains, fatty acids, steroid compounds) which are stabilized at neutral pH by hydrophobic dispersive forces (van der Waals, π–π , and CH–π bondings). Their conformations grow progressively in size when intermolecular hydrogen bondings are increasingly formed at lower pH's, until they flocculate.
>
> Fulvic acids may be regarded as associations of small hydrophilic molecules in which there are enough acidic functional groups to keep the fulvic clusters dispersed in solution at any pH.
> (Piccolo, 2002)

All of the characteristics laid out by the polymer theories for HA and FA are not in conflict with these definitions. The only difference is the bonding mechanism and what that implies for the molecules themselves. For the purposes of this article, either polymers or supramolecular associations will work as the difference in bonding is not critical to the final result of how HA and FA interact with their environments. Both concepts are looking at the same evidence and trying to understand what it means. This article is more focused on the role HA and FA play rather than why and how they play it.

Another possible view would be a combination of both polymers and supramolecular associations. It could be argued that the principles stressed in the supramolecular associations theory apply most clearly to FA since it is the smallest and most unique of the humic substances. Both the polymer theories and supramolecular associations theory realize that FA has characteristics seen nowhere else that must be accounted for. As the molecules grow in size and become HA, the supramolecular associations begin to become polymers as they grow more complex. The supramolecular associations never go away because FA is a part of HA. In this view then both polymers and supramolecular associations coexist with polymers becoming more and more prevalent the larger the molecules become and supramolecular associations become more and more prevalent the smaller the molecules become.

Humic Acid/Fulvic Acid and Metals (Minerals)

Both HA and FA are known to be involved in three specific chemical reactions in soil.

1) **Electrostatic (coulombic) attraction:** Both HA and FA have anionic sites that attract mineral cations. FA has more than HA but both have them. The mineral cations are loosely attached and can be easily released when it comes into contact with a stronger electrical charge in a plant cell. They are thus easily absorbed through roots or leaves. Both HA and FA minerals can be absorbed through roots. HA minerals cannot be absorbed through leaves but FA minerals can because of their relatively small size.
2) **Complex formation or chelation:** The electrically charged sites from number 1 function to dissolve and bind trace minerals in the soil. Both HA and FA use the presence of multiple anionic sites to bring about the dissolution of primary and secondary minerals within the soil. When minerals combine with more than one anionic site they form more complex molecules. This process is called chelation. These minerals then become available for uptake by plant roots. In their natural state, most minerals can be toxic to plant roots but when chelated they become available for absorption.
3) **Water bridging:** Water bridging involves the attraction of both a water molecule and a cation to an anionic site. Both the water holding capacity and the mineral binding ability of HA and FA work together in water bridging. This process improves the mobility of nutrient ions through the soil solution to the root.
   (Pettit, 2004)

Polyelectrolytes

One of the most important roles minerals play in both HA and FA is the formation of polyelectrolytes. A polyelectrolyte is defined as a “polymer composed of macromolecules in which a substantial portion of the constitutional units contains ionic or ionizable groups, or both.” (Hess et al., 2006) Basically, the theory holds that electrolytes in both HA and FA join together to form chains that enhance their electrolyte properties. Many acids are monomeric but HA and

FA are both polymeric acids. The idea that both HA and FA are polyelectrolytes is further recognition of the complexities of these humic substances.

The idea that HA and FA are polyelectrolytes is based on the polymer theory of their nature which requires viewing FA as a unique species of polymer (Yamauchi et al., 1984). Even if we reject the polymer theory and instead embrace the supramolecular associations theory, it does not negate the observations and properties that led to their designation as polyelectrolytes. These properties can still be true even if the molecules are not bound as polymers but are bound in other ways.

As discussed above, a combination of both the polymer theory and the supramolecular associations theory is possible and can be applied to polyelectrolytes as well. In this view the chains would become more prevalent in HA and grow stronger the larger the molecules become. In FA the chains would become smaller and more random the smaller the molecules become, until they are not chains at all but random groupings.

Humates

Humates are metal (mineral) salts of humic acid (HA) or fulvic acid (FA) (Pettit, 2004). According to acid-base theory they would be the conjugate bases of each. The term fulvate can also be used for ones coming from FA but this is usually only used when describing specific compounds like iron fulvate. The term humate is usually used to apply to salts coming from both HA and FA.

Humates are formed when the carboxyl (COOH) and hydroxyl (OH) groups deprotonate (lose one or more hydrogen protons) and become anions. The anions attract the metal (mineral) cations to once again become electrically neutral. This then adds minerals to the HA or FA changing it into humate. When the hydrogen proton is present, it is the acid, when the mineral is present, it becomes the base. Because there is a large variability in the source of the minerals, the humate composition of any humic substance is specific to that substance. “Humates from different mineral deposits would be expected to have their own unique features.” (Pettit, 2004) Humate geologic deposits are found in many different locations around the world.

Therapeutic Properties of Humic Acid/Fulvic Acid

Below is a summary of the findings for the therapeutic applications of HA and FA as found in Shilajit, peat, sapropel, and mumie. HA and FA are the primary and key components in Shilajit that explain its medicinal qualities (Pant et al., 2012). HA and FA are the main substances found in peat, sapropel, and mumie that are of medicinal importance (Schepetkin et al., 2002). Shilajit and mumie are essentially two terms for the same substance with Shilajit being the Sanskrit term and mumie being the Russian term (Pant et al., 2012 citing Murkherjee, 1992 and Chopra et al., 1958 and Bucchi, 2000).

1) **Oriental Medicine Panacea:** HA and FA have been used in oriental medicine for centuries to treat cold stress, diabetes, skin diseases, rheumatic pain, kidney stones, heart ailments, leprosy, and immune system diseases (Schepetkin et al., 2002).
2) **Ayurveda Wonder Drug:** As the active ingredients in Shilajit, HA and FA have been

used for centuries in ancient Indian Ayurveda medicine (Pant et al., 2012; Winkler et al., 2018 citing Wilson et al., 2011).

3) **Nonirritant:** HA (10% solution) does not cause sensitivity or irritate (Schepetkin et al., 2002 citing Wiegleb et al., 1993).
4) **External Treatment:** HA and FA used as external treatment for hematoma, phlebitis, desmorrhexis, myogelosis, arthrosis, polyarthritis, osteoarthritis, and osteochondrosis (Schepetkin et al., 2002 citing Laub, 1999).
5) **Internal Treatment:** HA and FA used as internal treatment for gastritis, diarrhea, stomach ulcers (antiulcerogenic and antistress activity), dysentery, colitis, and diabetes mellitus (Schepetkin et al., 2002 citing Yudina et al., 1996, 1998; Laub, 1999).
6) **Bone Growth:** HA and FA stimulate bone growth on transplanted bones (Schepetkin et al., 2002 citing Schlickewei et al., 1993).
7) **Aids in Blood Formation:** FA helps iron absorption making it bioavailable for bone marrow to use in blood formation (Meena, 2010 citing Dash, 1991 and Bhishagratna 1998).
8) **Antiallergenic:** FA possesses antiallergenic properties in animal testing (Schepetkin et al., 2002 citing Dekker and Medlen, 1999 and van Rensburg et al., 2001).
9) **Antimicrobial:** FA has antimicrobial properties (Schepetkin et al., 2002 citing van Rensburg et al., 2000). FA used as a sanitizer clinically demonstrated to reduce several bacterium (Zhu, 2014).
10) **Antiviral:** Ammonium humate from peat used to treat herpes simplex virus type 1 and type 2 and influenza virus type A and B (Schepetkin et al., 2002 citing Thiel et al., 1977 and Schiller et al., 1979 and Thiel et al., 1981 and Hils et al., 1986). HA can decrease HIV infection and replication (Pant et al., 2012 citing Mauizio, 2002 and Dekker, 2003).
11) **Anti-Inflammatory:** HA has anti-inflammatory properties (Pant et al., 2012 citing Peña-Méndez et al., 2005). FA has anti-inflammatory properties (Pant et al., 2012 citing van Rensburg et al., 2001).
12) **Antitoxic:** The adsorbent capabilities for poisons and mutagen molecules of both HA and FA may explain their antitoxic and desmutagenic effects (Schepetkin et al., 2002 citing Sato et al., 1987 and Badaev et al., 1989 and Ferrara et al., 2000).
13) **Anti-mutagenic:** HA inhibited the mutagenic nature of several hydrocarbons and pathogens (Schepetkin et al., 2002 citing Sato et al., 1987).
14) **Powerful Antioxidant:** FA possesses superoxide and hydroxyl radical scavenging properties (Schepetkin et al., 2002 citing Wang et al., 1996). HA compounds are excellent antioxidants (Pant et al., 2012 citing Schepetkin et al., 2003 and Peña-Méndez et al., 2005).
15) **Immune Enhancer:** HA and FA increase macrophages, neutrophils, killer T-cells (Schepetkin et al., 2002 citing Riede et al., 1991 and Laub, 1999).
16) **Aids Blood Clotting:** HA shortened prothrombin time and inhibited plasma protein C activity (Schepetkin et al., 2002 citing Lu et al., 1990 and Yang et al., 1994).
17) **Chelator:** FA is a natural chelator and cation exchanger (Schepetkin et al., 2002 citing Schnitzer and Khan, 1972).
18) **Nutrient Transport:** FA may act as carrier molecules or chelating agents for the more bioactive smaller compounds (Schepetkin et al., 2002 citing Ghosal et al., 1991; Meena, 2010 citing Shenyuan et al., 1993; Pant et al., 2012).

19) **Cancer Preventive Properties:** Both HA and FA have cancer preventive properties (Pant et al., 2012 citing Peña-Méndez et al., 2005).

Humic Acid/Fulvic Acid vs Himalayan Pink Salt and Ocean Water Salt

Since antiquity salt has played an important role in human society. Its preservative values alone made it necessary for commerce and the movement of peoples. Throughout history it has been natural sources of salt that were used along with all of the minerals that came from those salt deposits. With the coming of the industrial revolution, salts' natural source was replaced with refined salts that lost the benefits of the accompanying minerals. In recent times, there has been a return to natural salts in the form of Himalayan pink salt and ancient ocean salts. These are touted for the numerous trace minerals they possess just like humic acid and fulvic acid.

Although these salts do contain numerous trace minerals that both plant and animals need, the form these minerals take in the salts are not bioavailable in the same way as those found in humic acid and fulvic acid. One of the key roles HA and FA play in the soil is to stop salts from forming. In fact, salty soil can be rehabilitated by the introduction of enough humus and humic substances.

Both Himalayan pink salt and ancient ocean salts may provide many benefits but as sources of trace minerals, they pale in comparison to HA and FA.

Humic Acid/Fulvic Acid vs Alkaline Waters

Many alkaline waters tout the numerous trace minerals and electrolytes they provide. The same issue arises with them that arises with natural salts. The form of the trace minerals is not bioavailable like the trace minerals found in HA and FA. There is a unique process happening in a humic solution that contains both HA and FA along with the numerous other nutrients. This process produces life giving nutrients that no other source from man or from nature can produce.

Humic Acid/Fulvic Acid and the Environmental Sciences

The advent of manufactured NPK fertilizers in the place of humus and naturally fertile soil has caused massive disruptions in the agricultural industry. There is a movement now that is focused on returning to the benefits of humus and humic substances. The isolation of the NPK nutrients necessarily loses the many benefits that can only come from the natural processes that form humus and humic substances. Since these cannot yet be replicated by man, manufactured fertilizers cannot provide all that humus and humic substances do.

Beyond this, the role of humus and humic substances in reclaiming toxic sites by neutralizing toxins in the soil is gaining in popularity. Both industry and government are turning to these sources for their natural purifying properties. Again the sum of the whole in humus and humic substances is greater than its parts. (Pandey et al, 2000; Kochany et al., 2001; Burlakovs et al., 2013)

Conclusion

Humic acid and fulvic acid play a crucial role in soil health and soil fertility as part of the humic substances that make up humus. They are the product of nature itself and their complexity makes duplication by manmade means impossible. Exactly how nature weaves them together and creates their unique properties is still largely unknown. As stated in the introduction, humic substances can be defined as the organic compounds in soil that cannot be classified as any other chemical class of compounds (Gaffney et al., 1996). Even though the adaptability and flexibility of humic substances defies specific classification, the properties governing each component are known in general terms. What is also known is the benefits they produce to the soil and to the plants and animals that depend on it.

Although there is no universal standard laboratory test for establishing the amount of humic acid and fulvic acid in any one sample, the supplier of the HA and FA found in Humic/Fulvic Minerals & Electrolyes™ uses the testing standards set forth by the Humic Products Trade Association. Their testing calculates the HA at 22% and the FA at 25%. The remaining 53% is the trace minerals present and the aqueous solution the HA, FA, and minerals are suspended in.

Humic/Fulvic Minerals & Electrolyes™ is an organically extracted liquid fulvic-humic acid from raw natural humates. These humates come from pristine deposits in the western United States that are around 80 million years old. It should be noted that the only testing done on the humic-fulvic acid found in Humic/Fulvic Minerals & Electrolyes™ was to establish what minerals it contains, to establish it is free from any microbes, and to establish it meets organic food standards.

As noted in the introduction, the humic acid and fulvic acid used in Humic/Fulvic Minerals & Electrolyes™ is certified organic by the USDA, the Canadian Organic Foods Program, The European Union Organic Foods Program, and the Japanese Ministry of Agriculture (Organic Foods program). To go a step further, the humic acid and fulvic acid in Humic/Fulvic Minerals & Electrolyes™ are also Kosher Certified by Kosher Supervision of America (KSA), Los Angeles, California. It is not labelled as organic or kosher because our cGMP FDA regulated bottler is not certified organic or kosher but the ingredients are.

Based on the research provided in this article, Humic/Fulvic Minerals & Electrolyes™ can be expected to possess the properties listed below. Humic/Fulvic Minerals & Electrolyes™ has not been independently tested to prove the validity of any of these statements for any particular production batch. However, the following statements have scientific support based on studies of humic and fulvic acids as currently defined and identified.

- **NUTRIENT DENSE –** contains more than 70 minerals and trace elements that provide the essential nutrition necessary for cell health, cell balance, cell growth, and replication.
- **UNIQUE NATURE –** The minerals and trace elements are polyelectrolytes and supramolecular structures. The unique nature of these colloids diffuse easily through membranes, e.g. cell walls, when all other colloids do not.
- **LOW MOLECULAR WEIGHT –** Fulvic acid's low molecular weight helps it penetrate cellular walls more easily by reducing the surface tension. This allows cells to more

easily and efficiently respirate, hydrate, absorb minerals, amino acids and other nutrients, and eliminate waste.

- **AID CELL METABOLISM** – Once in the living cell, the minerals and trace elements found catalyze vitamins within the cell and help metabolize proteins, RNA, and DNA.
- **AID ELECTROCHEMICAL BALANCE** - help cells maintain electrochemical balance within themselves and amongst surrounding cells because of the presence of polyelectrolytes.
- **NATURAL CHELATOR** – Humic acid and fulvic acid are known in environmental science to bind with heavy metals and other toxins in the soil. Further, it works within the cells to promote oxidation-reduction reactions of heavy metals and other toxins to minimize the damage they can inflict on the body's tissues. They also promote oxidation-reduction reactions of transition metals (minerals) so the cell can utilize them.
- **IMMUNITY ENHANCER** – Humic acid and fulvic acid can increase macrophages, neutrophils, killer T-cells. Fulvic acid has antimicrobial properties and humic acid has antiviral properties.
- **ANTITOXIC AND ANTIMUTAGENIC** – Both humic acid and fulvic acid have adsorbent capabilities for poisons, toxins, and mutagen molecules.
- **ANTIOXIDANT –** Both humic acid and fulvic acid have antioxidant capabilities.
- **ANTI-INFLAMMATORY –** Both humic acid and fulvic acid have anti-inflammatory properties.
- **INTERNAL AND EXTERNAL APPLICATIONS** – Both humic acid and fulvic acid have been used effectively to treat various ailments occurring both outside and inside the body.

DISCLAIMER

This article is intended for informational purposes only and not as a substitute for professional medical consultation, prevention, diagnosis, and treatment. The information provided is not intended to diagnose, treat, cure, or prevent any disease or condition. If you suspect you may have a disease or condition, you should consult a licensed healthcare practitioner.

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