

# Oligodynamic Ag<sup>+</sup>: The Active Ingredient in Sovereign Silver and Argentyn 23 From Natural-Immunogenics Corp.

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## Introduction

By 1937, the 3 factors governing the oligodynamic action of silver – (a) *particle charge*, (b) *particle size* and (c) *particle concentration* - were known.<sup>1</sup>

Carl Nageli (1893) first defined the oligodynamic effect (from the Greek *oligos* = few, and *dynamis* = power) to best describe how extremely low metal *ion* concentrations beyond definitive chemical analysis exert potent biocidal actions. Webster's Dictionary gives further definition to the biocidal properties of extremely low metal ion concentrations as follows: Ol-i-go-dynamic *adj* [ISV *olig* + *dynamic*, orig. formed as G oligodynamisch] 1: active in very small quantities <an ~ germicide> 2a: produced by very small quantities <~ action of finely divided silver in disinfecting water> b: of or relating to the action of such quantities.<sup>2</sup>

The subject of this review is a new, high tech oligodynamic silver ion speciation (Sovereign Silver, Millenia, Argentyn 23) that yields the following attributes:

- a. A true picoscalar oligodynamic Ag<sup>+</sup> speciation;
- b. A uniform particle charge yielding +95% as Ag<sup>+</sup>;
- c. A uniform dispersion comprised of average particle sizes of 0.8 Ångstroms;
- d. A concentration of 10 ppm, 11 ppm, and 23 ppm respectively;
- e. A Particle Diffusion Co-efficient of 10<sup>-5</sup> cm<sup>2</sup>/second;
- f. A minimum of 1,500,000,000 (Sovereign Silver and Millenia) to 6,000,000,000 (for Argentyn 23) active charged particles per cc;
- g. Sterile (Sovereign Silver and Millenia) and Pyrogen-Free, suitable for medical administration (Argentyn 23);
- h. Hypo-osmotic, providing purity and preservation of benefits for low quantity usage.

## Particle Charge

Silver based products can be made electrolytically or chemically. No matter what the manufacturing method, the differing metal compounds derived are referred to as speciations.<sup>a</sup> In both cases, the goal is produce biologically available silver with low toxicity profiles, which is always based upon the total resulting silver ion (Ag<sup>+</sup>) quantity or concentration. In colloidal vehicles, the toxicity factor for silver ions can be nearly eliminated, providing the colloidal state is stable and state-of-the-art.

Electrolytic Method: An authority on silver oligodynamic properties, Alexander Goetz, remarked that Ag<sup>+</sup> concentrations can vastly exceed any known chemically created silver compound when made by the electrolytic method.<sup>3</sup> As early as 1929, Voigt proved that Ag<sup>+</sup> could be concentrated into such electrolytic suspensions (called silver hydrosols) as opposed to exclusively neutral Ag.<sup>4</sup> From these two methods, many different speciations of immune enhancing silver-formulas have been made, but not until recently has advanced technology finally realized the full potential as conceived by Goetz.<sup>5, 6</sup>

The term oligodynamic is only applicable to extremely low concentrations of Ag<sup>+</sup> whether these ions derive from chemical or electrolytic production methods. This minimizes toxicity, so the term should be used as a hallmark standard in silver-based health products. However, it is only with colloidal technology that oligodynamic properties can achieve their greatest potential due to surface area and surface energy thermodynamics. (See particle size next.)

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<sup>a</sup> Speciation is a term created to precisely describe the physical and chemical properties of metals that determine their fate, toxicity and transport in biological environments.

Acél was perhaps the first to observe that the oligodynamic action of silver was due to liberated  $\text{Ag}^+$  as opposed to metallic (neutral) Ag.<sup>7</sup> Eichorn has emphasized that the charge significantly facilitates electron displacement. The oligodynamic metal charge effectively yanks electrons away from another molecule (such as a bacterial membrane), in essence weakening the molecular bond and rendering it susceptible to cleavage.<sup>8</sup> Goetz emphasized that, “the ionized state of silver is of fundamental importance for an oligodynamic effect; at the same time, the experimental evidence seems to indicate definitely that Ag, once bound to organocolloids (i.e., mild silver protein), almost completely loses its ionized state.”<sup>9</sup> As Goetz’s knowledge evolved in realizations of the finer points of silver oligodynamics, he eventually and correctly concluded that silver is microcidal only *if* it is in the ionic state,<sup>10</sup> as was more recently established by the work of Rochart and Uzdins who observed cells selectively bond only with silver ions.<sup>11</sup>

**Chemical Method:** Silver salts are typically made through the chemical method. As far as the salt speciations of silver are concerned, the *CRC Handbook to Chemistry and Physics* states that, “While silver itself is not considered to be toxic, most of its salts are poisonous.”<sup>12</sup> Why is this?

In a nutshell, the toxicity of silver salt speciations are due to: (a) the high concentration of salts necessary to liberate biologically meaningful amounts of  $\text{Ag}^+$ , coupled to (b) the “caustic” pharmacodynamics of the anion. In other words, the lethal actions (i.e., oligodynamic activity) of heavy metal salts are only attainable from high silver salt concentrations because it is only in high concentration that  $\text{Ag}^+$  cations – restrained by a relatively short ionic bond length - attain sufficient exposure thresholds against pathogens. Furthermore, with silver salts their solubility (which is directly related to the length of or distance between the cation/anion ionic bond) **is what determines or undermines the potential for surface area exposure and adsorption of  $\text{Ag}^+$  upon a microbe.**

Recall that the length of the ionic bond is due to the dissociation constant of the solvent governing the separation between the salt’s cation and anion content. To paraphrase Goetz, as far as the purely chemical oligodynamic activation is concerned, it appears certain that only the solubility of the compound formed at the metal surface determines its activity. For example, a silver surface activated by means of sulfadiazine (SD) or nitrate ( $\text{NO}_3$ ) anion will obtain an oligodynamic activity equivalent to an Ag concentration that corresponds to the *solubility* of the  $\text{AgSD}$  or  $\text{AgNO}_3$  in a given solvent (e.g., water, plasma or serum).<sup>13</sup>

Put another way, the salt related restrictive dissociation constants dictated by the solvent source does not play a factor in the colloidal silver hydrosols. Thus, when silver bonds into a “salt form” with phosphates, chlorides, sulfides, etc... this bonding reduces its surface and bactericidal activity.<sup>14</sup>

What we are undeniably left with is that silver salts have difficulty achieving biologically meaningful concentrations of  $\text{Ag}^+$ . Precise data compiled on over sixteen silver salt speciations, revealed that with the exception of silver nitrate ( $\text{AgNO}_3$ ), none could exceed 1.82 mg per liter (1.82 mg/L)  $\text{Ag}^+$  concentrations (the specific solubility product of these salts)!<sup>15</sup>

Silver Salt Speciation	Solubility Product ( $\text{Ag}^+$ in mg/L)
$\text{AgC}_2\text{H}_3\text{O}_2$ (Silver acetate)	1.82
$\text{AgBr}$ (Silver bromide)	$4.1 \times 10^{-10}$
$\text{Ag}_2\text{CO}_3$ (Silver carbonate)	$6.15 \times 10^{-9}$
$\text{AgCl}$ (Silver chloride)	$1.56 \times 10^{-7}$
$\text{AgCN}$ (Silver cyanide)	$2.2 \times 10^{-9}$
$\text{AgI}$ (Silver iodide)	$3.2 \times 10^{-12}$
$\text{Ag}_2\text{O}$ (Silver oxide)	$1.52 \times 10^{-5}$ ( $\text{AgOH}$ )
$\text{Ag}_2\text{S}$ (Silver sulfide)	$1 \times 10^{-46}$ to $10^{-49}$

(Adapted from Table 1. – Solubility of Silver Compounds in Water, converted into mg/L)<sup>16</sup>

We owe much to the advanced insight of Goetz (1954). It was twenty years later that Berger *et al.* (1976), and Simonetti *et al.* (1992), illustrated conclusively the superiority of electrolytically produced oligodynamic  $\text{Ag}^+$  speciations over chemically derived oligodynamic speciations during the last decade.

*Antimicrobial Agents and Chemotherapy*, Feb 1976; 9(2): 357-8.

#### **Electrically Generated Silver Ions: Quantitative Effects on Bacterial and Mammalian Cells**

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**Abstract:** The inhibitory and bactericidal concentrations of electrically generated silver ions were 10 to 100 times lower than for silver sulfadiazine. Effects on normal mammalian cells were minimal.

*Applied and Environmental Microbiology*, Dec 1992; 58(12): 3834-3836.

#### **Electrochemical $\text{Ag}^+$ for Preservative Use**

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**Abstract:** In contact experiments with different experimental conditions, electrochemical  $\text{Ag}^+$  solutions exhibited better antimicrobial effectiveness against bacteria, a yeast species, and a mold than did analogous silver solutions from inorganic salts. The particular characteristics of electrochemical  $\text{Ag}^+$ , such as the mode of action, effectiveness at low concentrations, and stability, indicate that  $\text{Ag}^+$  could be used effectively in preservatives.

With today's technology, one high-end commercially available colloidal silver hydrosol product actually achieves levels of  $\text{Ag}^+$  that **exceeds 23 mg/L, the highest ever documented.**<sup>17</sup> This is a perfect illustration why pharmacokinetically and pharmacodynamically different silver speciations may differ by several *orders of magnitude* in their respective Therapeutic Index (TI).

In addition to the total concentration of  $\text{Ag}^+$ , the  $\text{Ag}^+$  net surface area advantage attained by nano- or picoscalar colloidal  $\text{Ag}^+$  particles attain many more orders of magnitude in their respective TI. When added together, these two distinctions form the huge pharmacokinetic/pharmacodynamic gap - by multiple *orders of magnitude* - between silver salts verses colloidal silver hydrosols rich in  $\text{Ag}^+$ .

In closing the introduction, it is hoped the reader takes away the impression of just how colloidal technology can maximize the relationship between speciation, pharmacokinetics, pharmacodynamics and the Therapeutic Index. Furthermore, it is hoped this introduction suggests in a compelling sense the supreme role colloidal technology plays over inorganic or organic chemistry when the therapeutic goal is to achieve **a minimizing of toxicity and a maximizing of efficacy.**

#### **Particle Size - Dissociation Constant versus Colloidal Surface Area:**

Size: One critical characteristic of metal ions, central to their chemical and biological activity, is **size** → an important factor in determining whether one metal can replace another in a given environment.<sup>18</sup>

Because of this plus other physical attributes, this is one of several reasons why the smaller the *colloidal* silver particle the more biologically active it becomes. The other reasons stem from the thermodynamics harnessed by smaller and smaller colloidal particles (i.e., Brownian movement and surface energy), in addition to their acquisition of Zeta-Potential (which is more related to the particle charge coupled to particle size). Colloidal silver particles in commercial products of the last century were thought to be 0.014 to 0.026 microns (14 to 26 nanometers). Due to advanced technology, at least one professional

grade silver hydrosol product has achieved a 0.8 nanometer average particle size, the first known picoscalar oligodynamic  $\text{Ag}^+$ . The significance of this is further revealed when contemplating the relationship surface area has to biological environments.

**Surface Area:** The key strategic advantage of colloidal-based drugs over simple drug compounds is the ability of the former to adsorb and penetrate into the greatest possible biological area in the lowest possible effective dose. This issue of *surface area* is of utmost importance. The activity of biocatalysts like colloidal silver is directly proportional to the adsorption power upon a biological surface.<sup>19</sup>

Bechhold, Alexander, Jirgensons & Straumanis, and Hartman all adapted tables from Wolfgang Oswald who demonstrated the geometric progression to the surface area of silver particles by assuming a starting point of 1 cubic centimeter of silver. Reducing incrementally into smaller and smaller cubes, the silver particles eventually disperse over *six square kilometers of surface area*.<sup>20, 21, 22, 23</sup>

$$1.0 \text{ cm} = 6 \text{ cm}^2$$

$$1.0 \text{ micron} = 6 \text{ m}^2$$

$$1.0 \text{ nanometer} = 6 \text{ km}^2.$$

In summary, Kopaczewski concluded as early as 1928 that the *net* colloidal particle size meant a great deal to the oligodynamic effectiveness of any colloidal silver preparation. He consistently observed that only the finest dispersed colloidal particles had the desired antiseptic effects.<sup>24</sup>

### Particle Concentration

In 1893, Nägeli determined that oligodynamic  $\text{Ag}^+$  was an effective biocide at concentrations ranging between 0.000001% to 0.00006% (equivalent to  $9.2 \times 10^{-9}$  M to  $5.5 \times 10^{-6}$  M, respectively, or 9.2 ppb to 5.5 ppm) *in vitro*.<sup>25</sup>

In 1970, a NASA sponsored study confirmed in principle Nägeli's findings *in vitro* that oligodynamic  $\text{Ag}^+$  was a highly effective biocide in concentrations of 50 ppb over 4 hours or less, and in concentrations of 250 ppb over 2 hours or less.<sup>26</sup> As advances in understanding occurred, it was determined that raising the silver ion concentrations to 10 ppm or more reduced the necessary time of exposure to mere minutes.<sup>27</sup>

Historical effective concentrations *in vivo* typically required achieving a total oligodynamic  $\text{Ag}^+$  target tissue load of from 1 ppm to 10 ppm. This is covered and documented in later sections.

### Review:

This section has addressed and identified the "full-bodied state" of *active* oligodynamic silver. In the past due to the technological inability to create commercially viable amounts of active colloidal  $\text{Ag}^+$  particles, silver speciations were pharmacokinetically and pharmacodynamically inferior and posted only a moderate to poor Therapeutic Index (TI). Thus, the oligodynamic effect became either forgotten or cloaked in misrepresentations. Consequentially, nearly every silver speciation was readily replaced by the era of antibiotics.

However, due to modern day technology, it can now be argued that the most biologically useful silver speciation, for higher versus lower life forms, would be colloidal silver hydrosol in a "picoscalar  $\text{Ag}^+$ " speciation. Such a silver speciation would bring to the TI multiple orders of magnitude in safety and efficacy.

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