The Janus Corner

The Janus Corner

This occasional section within the journal surveys visions and achievements, often not on the main track of the developing biomedical sciences, but all relating to discoveries and developments of medicinals – both ancient and modern. What they have in common, in one way or another, is providing further background and glances around the edges of the core discipline of pharmacognosy, as it has been and continues to evolve within our times.

BOOK REVIEW

Michael Whitehouse (Prof)
Griffith University Medical School
Qld Australia
Email: whitehousemd@spin.net.au

Pharmacognosy Communications
Volume 3 | Issue 4 | Oct–Dec 2013
www.phcogcommn.org

The Janus Corner

Ben Goldacre: Bad Pharma. How Drug Companies Mislead Doctors and Harm Patients

New York Faber & Faber, 2013, pp.426 (also a paperback edition 2012)

"There will be no medicine without medicines."

This most timely book is quite discomforting but should certainly be read by anyone interested in prescription drugs. It is also very relevant for proponents of alternative medicines, nutritional supplements and OTC medications. If the pharmaceutical industry and the powerful drug regulators have their way, these non-prescription drugs will be heavily purged, not because of inefficacy but due to high costs of conducting extended clinical studies to obtain proposed regulatory approval.

Already it is horrifying to compare present costs of vitamin C, fish oils and several other nutritional supplements in the UK and Europe with for example their costs in Australasia. This is largely because some pharmaceutical companies have become major approved distributors or they are trying to either increase their share of the market or effectively restrict their availability in favour of their more expensive patented medications for antibiosis, oxidant stress, inflammation, immunoregulation, etc. Even more incredible is the proposal that some of these long used and well proven supplements should only be available on prescription, adding yet further to their costs for the consumer. If this stealthy takeover is tolerated, these medicines would no longer be freely accessible; the market being further controlled by interests concerned solely with exclusivity and high profits.

Ben Goldacre is also the acclaimed author of Bad Science and a noted communicator of medical affairs from the perspective of a practising and very well read physician. He writes, "Although this book is about problems, the goal is that pharma should be adequately regulated and transparent to the extent that academics (scientists and medicos) can feel positive and enthusiastic about collaborating with it."

The incisive Introduction section of Bad Pharma begins with the observation that "Medicine is broken, because the evidence we use to make decisions is hopelessly and systematically distorted. If those decisions are misguided, they can result in death, suffering and pain. These problems have been protected from public scrutiny…. The people you should have been able to trust to fix these problems have failed you…. For several of the most important and enduring problems in medicine, we have no idea what the best treatment is because it's not in anyone's financial interest to conduct any trials at all."

These quotations set the tenor of a detailed analysis of what has gone wrong, e.g. the missing data such as the unpublished often vital negative studies held back from those who could use it/them.

"There is no way we can practise medicine safely as long as the industry continues to withhold this data…. Every moment that the pharmaceutical industry continues to hide it from us more patients are harmed: this is an ongoing crime against all humanity and it is happening under all our noses." Strong words indeed, but the very extensive text presents facts and references for the reader to question/accept these conclusions.

The introduction is followed by chapters covering Missing data (99 pages); Where do new drugs comes from (21 pages); Bad regulators (48 pages); Bad trials (51 pages); Bigger, simpler trials (16 pages); Marketing (100 pages); with an afterword about Better data and a further 35 pages as "Notes". In the last chapter (Afterword) there is a final section entitled "Clearing the decks" which clearly states, "Medicine today is practised using drugs that have come on to the market over several decades supported by evidence that has been gathered since at least the 1970's. We now know that this entire evidence base has been systemically distorted by the pharmaceutical industry which has deliberately and selectively withheld the results of trials whose results it didn't like, while publishing the ones with good results."

The biggest chapter of the book - on dodgy marketing – is filled with horrors that you mustn't miss. It all reminded

me of Georges Halpern's commentary, "Cox-2 inhibitors: a story of greed, deception and death" (Inflammopharmacology 2005; 13:419–425.

Another reviewer of this book (Max Pemberton, The Telegraph, UK) summarised it as showing all too clearly "how big business put profits before patient welfare allowing them to die rather than disclose damning research evidence".

Readers should note these are the people who would now deny us much of the benefits of pharmacognosy i.e. knowing our alternative medications, their traditional usage and general safety (without which they would have no place among acceptable pharmaca).

For those who have the time and patience to read on, here are some further pithy excerpts from this remarkable book (included with the author's approval).

"Doctors need to learn about new drugs all the time but we leave them to get on with it by themselves….The state doesn't want to pay for it so the pharmaceutical industry pays instead. Departments of health spend a few million pounds providing independent medicines information to doctors. The industry spends tens of billions on providing biased information."

An inescapable conclusion is that the industry has manipulated the regulatory processes and their marketing arms have taken over the continuing education of the doctors to suit their purposes, largely excluding unpatented products and alternative voices respectively.

"Bad trials can be fundamentally flawed by both design and analysis, in ways that exaggerate benefits and underplay harms. Some of the quirks and distortions are straightforward outrages …. In many cases corners are cut because of perverse incentives (to save money or get faster results)."

"Ninety per cent of published trials are sponsored by the pharmaceutical industry. They dominate this field, they set the tone and they create the norms."

"The problem of trial patients being unrepresentative is called 'generalisability'. It can make a trial completely irrelevant to real-world populations. Yet it is absolutely routine for research, which is conducted on tight budgets, to tight schedules, for fast results, by people who don't mind if their results are irrelevant to real-world clinical questions. This is a quite dismal scandal … Just a slow and unnecessary pollution of almost the entire evidence-base in medicine."

"Amateur critics often like to dismiss anecdotes as 'unscientific' but this is wrong: anecdotes are weaker evidence than trials but they are not without value and are often the first sign of a problem."

"Evidence in medicine is not an academic preoccupation. Evidence is used to make real-world decisions, and when we are fed bad data, we make the wrong decision inflicting unnecessary pain and suffering and death on people just like us."

"Missing data poisons the well for everybody. If proper trials are never done, if trials with negative results are withheld, then we simply cannot know the true effects of the treatments we use. With missing data, we are all in it together and we are all misled … our best estimate was that half of all clinical trials go unpublished."

"We now know that this entire evidence base has been systemically distorted by the pharmaceutical industry, which has deliberately and selectively withheld the results of trials it didn't like while publishing the ones with good results …. These industries now accept they rig the academic literature and that this practise was widespread. We need to see which academic papers are covertly written by paid industry staff."

"Medicines marketing only exists for one reason. In medicine, brand identities are irrelevant there's a factual objective answer to whether one drug is the most likely to improve a patient's pain, suffering and longevity. Marketing therefore exists for no reason other than to pervert evidence-based decision-making in medicine …. About a quarter of the money taken by pharmaceutical companies for the drugs they sell is turned around into promotional activity which has a provable impact on doctors' prescribing."

"We have tolerated the emergence of a culture in medicine where information is routinely withheld and we have blinded ourselves to the unnecessary suffering and death that follows from this. The people that we should have been able to trust to handle all this behind the scenes … have almost all failed us."

In each chapter such generalisations precede detailed accounts of the bad happenings and they are disgraceful, even horrific – and certainly a disservice to the present and future patients (that includes all of us).

In summary, this is a fascinating authoritative account of some intolerable features of the 'medicines industry' today and our dependence on shoddy, often deliberately

misinformative data about efficacy and safety of prescription drugs. Most commendably, this book is a good read, well written and quite amazingly jargon free.

LETTERS TO THE EDITOR

The following were received as letters to the editor and are published here in their entirety. Letters to the editor express the opinion of the author(s) and may or may not reflect the opinion of the editor or the journal.

EDITORS NOTE

I.E. Cock, Editor-In-Chief, Pharmacognosy Communications

Pharmacognosy is the study of the biological, chemical and physical properties of drugs of crude mixtures or drugs from natural sources. Whilst the majority emphasis in this field is devoted to drugs from plant sources, animal but inorganic derived drugs are also an important sector of the study of pharmacognosy.[1] Just as the search for new drugs from plants requires us to look back to ancient medicinal practices to determine new ways to treating diseases, so too do other areas of our field. Crude inorganic or metallic solutions also have a history of therapeutic usage stretching back many hundreds of years and research into these ancient cures has recently begun to receive renewed attention.[2–5] Colloidal silver pharmaceutical (CSP) preparations in particular have recently emerged as a vigorous area of enquiry boosted by the ever-increasing alarm over the scourge of infectious disease organisms acquiring antibiotic resistance. Despite the incredibly large amount of references to CSP preparations easily available on the Web, they remain generally poorly understood. Relatively few studies have rigorously examined them for bio-efficacy as well as their physical and chemical properties and general stability (the latter being most important for considering the environmental impacts). Thus, there is a need to better understand CSP products before accepting their intrinsic worth as old drugs in a new format. This need to know is truly at the core of modern pharmacognosy in considering any useful pharmaca, whether or not they originate from the pharmaceutical industry or are not currently approved by the various regulatory agencies. With this in mind, we publish here 2 separate letters to the editor examining different aspects of CSP preparations.

REFERENCES

1. Cock IE. Editorial. Pharmacognosy Communications: The scope of Pharmacognosy. Pharmacognosy Communications 2011; 1 (1):1–3.
2. Cock I, Mohanty S, White A, Whitehouse M. Colloidal silver (CS) as an antiseptic: Two opposing viewpoints. Pharmacognosy Communications 2012; 2 (1):49–58.
3. Cho K, Park JE, Osaka T, Park SG. The study of antimicrobial activity and preservative effects of nanosilver ingredient. Electrachimica Acta, 2005; 51:956–60.
4. Shahverdi AR, Fakhimi A, Shahverdi HR, Mianaian S, Synthesis and effect of silver nanoparticles on the antibacterial activity of different antibiotics against Staphylococcus aureus and Escherichia coli. Nanomedicine: Nanotechnology, Biology and Medicine, 2007; 3:168–71.
5. van Hasselt P, Gashe BA, Ahmad J, Colloidal silver as an antimicrobial agent: fact or fiction. Journal of Wound Care 2004; 13 (4):154–5.

Pharmacognosy Communications
Volume 3 | Issue 4 | Oct–Dec 2013
www.phcogcommn.org

The Janus Corner

A Commentary: The Antibiotic Pot Calling the Silver Kettle Black

Hans Laroo*

Security R&D, Ipswich Qld, Australia

There is sufficient anecdotal and scientific evidence that organic antibiotics are: (1) being overprescribed, (2) becoming less effective as a means of dealing with bacterial infections, and (3) also responsible for making our drinking water more and more contaminated with waste pharmaceuticals.[1] This unwanted contamination is making it difficult, if not impossible to maintain the purity of drinking water to an acceptable standard. Silver is the most reflective material at most frequencies of the visible spectrum and as such there is no doubt that the 'organic antibiotic pot' only sees its own reflected blackness!

There is presently no convincing evidence to suggest that nano sized colloidal silver is a serious threat to the environment. Once returned to the soil, it re-forms to ordinary mineral silver aggregates joining the silver already present there. With that being the case, it begs the question why many researchers are trying to prove that nano sized colloidal silver is harmful to the environment. By contrast, the products generated by the international pharmaceutical industry are rarely considered in the same way. Even if there were some risks associated with colloidal silver, it would pale into insignificance when compared to the ever increasing threat of organic medicinal waste in the sewers and waterways. In order to maintain drinking water to an acceptable standard, water purification plants in the Netherlands have resorted to adding naturally filtered subterranean water to the normally used surface water. In a recent study, 12 pharmaceuticals and 7 transformation products were found to be present in the drinking water. Their concentrations were generally highest in the surface waters.[1]

The production of colloidal silver for therapeutic use not only differs from that used by industry for non-therapeutic use, but also in the way it is manufactured. This can take the form of chemical reduction of oxidised silver, e.g. silver nitrate, or by physical modalities, e.g. via electrochemically produced ionic silver being the most common. More recently, colloidal silver products from other methods of production have made their entry into the market. One of these methods is called the high voltage ablation. In yet another procedure, powdered bulk silver is just dumped into water. One producer uses electrical potentials as high as a few 100 kV for arcing silver electrodes in water (Bredig's method). The 'just add water' product may in fact proven to be bio-toxic, according to tests on minnow embryos at Purdue University.[2] One manufacturer of powdered bulk silver states in their brochure, "powdered silver is difficult to dissolve in water". It is hard to imagine that such products can in any way be compared to those derived from conventional production methods of producing medicinal colloidal silver in stable suspension. With such a diverse array of different production methods coupled with a complete absence of any standards or basic specifications as to what actually constitutes these various colloidal silvers, serious doubts must arise as to the quality and bio-efficacy of some of these poorly characterised colloidal silver products.

It can be readily shown that some of these production methods do not result in pure colloidal silver. In some of these dubious silver colloids, the silver content may be mostly ionic and in some cases also contaminated with various electrolytes, other metals such as copper, lead, etc or even arsenic. However, by exercising ultra-precise production control and engineering, such contaminations can virtually be eliminated. To really establish what constitutes medicinal quality colloidal silver it should be an obligation for all producers, to unequivocally display their specification as to its characteristics which should include particle size (and shape), Zeta potential, concentration, and the level of purity and contamination.

*Correspondence
Hans Laroo
E-mail: hlaroo@bigpond.com

CONCLUSION

Colloidal silver promises to be a potent inorganic antibiotic material. For continued progress and the general acceptance of this material, Industries that produce colloidal silver must agree as to what actually constitutes colloidal silver and embrace the use of standard specifications. Until this happens, any technical advances are bound to remain slow and more controversial than it needs to be. This no doubt, will result in yet more continued flawed and misleading reports on its bio-efficacy and inappropriate claims of toxicity.

REFERENCES

1. Cummins, J (2012). Pharmaceutical Cocktails for anyone? Widespread pollution of drinking water by unregulated discharges of pharmaceuticals is potentially damaging to health and the environment. Institute of Science in Society (ISIS) report 02.10.2012
2. Laban G, Nies LF, Turco RF, Bickham JW, Sepulveda MS. (2010) The effects of silver nano particles on fathead minnow (*Pimephales promelas*) embryos. Ecotoxicology; 19:185–95.

Pharmacognosy Communications
Volume 3 | Issue 4 | Oct–Dec 2013
www.phcogcommn.org

The Janus Corner

Dietary Supplement Silver Nanoparticles: No Threat to the Environment

George J. Maass*

(Prof. of Chemistry, Camden Co. College, Blackwood, NJ, and at Burlington Co.College, Mt. Laurel, NJ. Senior Scientific Advisor for Colloidal Science Laboratories, Westampton, NJ)

ABSTRACT: Silver is an effective germ fighter, and silver nanoparticles are widely recognized as being especially effective because of their enormously high surface area to mass ratio. Due to the large number of manufacturers using silver nanoparticles in their products, some concern has arisen about the effects on the environment when these products are disposed of or washed. There even have been concerns expressed about whether or not colloidal silver should be considered a "drug" because of its biological properties. This report will demonstrate that silver nanoparticles do not exhibit harmful properties, nor do they remain "nanosize" when they come in contact with normal environmental samples, such as soil and water, but they agglomerate to form much larger, much less biologically effective, silver particles, which are non-toxic, non-ionic, and have no history of being harmful to the environment or aquatic life.

INTRODUCTION

Silver is a very well known metal. One would be hard pressed to find someone who did not know something about silver, nor who thought of silver as anything but harmless and desirable. It has become evident, however, that colloidal silver, because of the exceptionally small size of the particles, has certain pharmacological properties which may have an effect on environmental biosystems. Recently, the U.S. Environmental Protection Agency (EPA) issued a statement that they were planning to regulate companies that produce nanoparticles for use as anti-microbials. This gives rise to the question, why are the dietary supplement and nanoparticle industries being targeted at this time, and what is the rationale for new regulation of an industry which has previously had no reported harmful effects to humanity or the environment?

The EPA knows that silver nanoparticles are effective as antimicrobials. The reason given by the EPA for their current interest is that silver nanoparticles, or products claimed to be silver nanoparticles, are now being produced by a number of manufacturers. The EPA is concerned that, when these particles are disposed of, there might be an appreciable amount of silver nanoparticles suddenly appearing in the environment. The proposed concern is due to the fact that the silver nanoparticles are so small that their surface area per unit weight is very large: therefore, for a given weight of product, the biological effectiveness, which is proportional to surface area, is far beyond that which would be expected. This much is true and it is part of the reason that silver nanoparticles are so attractive for biological applications. The EPA is not questioning the fact that silver nanoparticles are effective in killing harmful bacteria. Its concern is that, by disposing these particles into sewers or waterways, might there be harmful effects to the environment by eliminating the bacteria which are useful in normal waste degradation?

The last statement shows a misunderstanding of what silver nanoparticles are and what they do. Nanoparticle technology is relatively new to the scientific community for good reasons: nanoparticles are difficult to produce; once they have been produced they are not stable and more significantly they are not stable enough to exist/persist in the wider natural environment for very long.

The purpose of this research is to show that normal interaction of nanoparticles with various constituents of the environment, such as soils and different water sources, is sufficient to cause growth of the particle size and

*Correspondence
George J. Maass, Ph.D.
(Prof. of Chemistry, Camden Co. College, Blackwood, NJ, and at Burlington Co.College, Mt. Laurel, NJ. Senior Scientific Advisor for Colloidal Science Laboratories, Westampton, NJ).
E-mail: gjmchem@comcast.net

dramatically decrease the biological activity. The observations reported here indicate that silver colloids, which start out as nanoparticles, upon contact with the environment "grow" to much larger clusters, as indicated by their average particle size distribution, (a nanoparticle size measurement),and zeta potential measurements. The zeta potential is altered to be outside of the range required for nanoparticle stability.

Several recent articles show misunderstandings about silver and its nanoparticles. At Arizona State University, Westerhoff and Benn[1] have reported "findings" which have never been observed during the last 15 years at Colloidal Science Laboratories (CSL) claiming that nanosilver particles produce ionic silver when exposed to moisture. This is NOT true! This is tantamount to saying that silver metal is water soluble. At CSL, various forms of silver, ranging from solid silver metal to fine silver powder, have been exposed to water for long periods of time with agitation. No increase in conductivity or silver ion concentration has ever been observed when silver metal in any form is treated with water. Silver metal requires chemical treatment with an oxidizing agent, such as nitric acid or Aqua Regia to produce silver ions. Nor is it true that only silver ions have antimicrobial properties. Colloidal silver is a wonderful antimicrobial by itself, which is a good thing, because silver cations are very reactive with chloride anions to form insoluble, and biologically inert, silver chloride. This happens in the stomach, the bloodstream and in waterways wherever halide and phosphate anions are present.

As this report will show, the high biological effectiveness of colloidal silver does not persist in nature, because the nanoparticles agglomerate as soon as they come in contact with the environment, specifically soil and water. Westerhoff and Benn admit that silver particles "clump" together in the (silver-impregnated) fabrics and in the wash water. That is precisely the point to be considered for environmental safety. How much "clumping" does it take so that the particles are no longer considered to be "nano", but much larger and eliminating their (original) high biological activity.

We examined three different environmental conditions which change the morphology and stability of silver colloids:

(i) the effect of drainage of silver colloids through several soil samples.
(ii) the effect of interaction of silver colloids with different water samples.
(iii) the effect of exposure of silver colloids to sunlight.

EXPERIMENTAL

Sample Selection

The first two questions to be addressed were what environmental samples should be used and to what concentration of colloidal silver should these samples be exposed.

It was decided to limit the environmental samples to the following:

Sand, taken from the New Jersey shore
Soil, taken from central New Jersey,
Soil, taken from Northern Pennsylvania
Local tap water from Westampton, NJ
Sea water, taken from the New Jersey shore
Water from a northern Pennsylvania well

The soil samples represent some of the most common types found on the Eastern Coast of the United States. The sand is essentially an Entisol, a type of soil that is not subject to a great deal of chemical change and is common to areas where natural deposition and removal occur at regular intervals. The New Jersey soil is primarily an Ultisol, containing clay, quartz, kaolinite and various iron oxides. The Pennsylvania soil is most likely a mixture of Alfisols and Inceptisols, which are clays suitable for growing most crops and common to many areas.[2]

The water samples are sea water, rich in many salts, NJ tap water, subjected to routine purification, and Pennsylvania well water, which most likely contains carbonates and nitrates. This range of samples should be sufficient to establish any effect of the environment on silver nanoparticles for this initial study.

Approximately 8 to 10 lbs of each environmental sample were collected. From these, 18 to 20 samples of 20.0 g each were selected, and these were randomized for the testing. The amount of colloidal silver to be used, it was decided that the initial tests should provide information with regard to an overabundance of nanoparticles being released to the environment, rather than just a trace amount. If the environment is not substantially altered by the overabundance, it seems reasonable to assume it will not be influenced by smaller amounts.

Preliminary studies indicated that, at concentrations of up to 6 ppm silver, and probably higher, based on the weight of soil samples, no nanoparticles would survive. Therefore, a more reasonable amount, but still an enormously high concentration for a natural occurrence, was selected.

Colloidal silver samples were dietary supplements and averaged at least 20 ppm silver. Most soil samples require 0.5 to 0.75 their weight in water to start draining. Colloidal silver was therefore diluted 10 to 1 (with de-ionized water) and then applied to each soil sample, so that each sample contained a minimum of 2 ppm of silver nanoparticles, based on the weight of the soil. This would correspond to dumping 27 litres of 20 ppm colloidal silver onto one ton of dirt. Since most consumers of dietary colloidal silver are concerned with teaspoon and tablespoon quantities, it also seems reasonable to assume that the quantities used for this experiment cover something well above the worst case scenario.

Measurements

In each experiment, the selected sample of colloidal silver was mixed with the environmental sample and the change in particle size and zeta potential recorded after a specified time using the Malvern Zetasizer, model Nano ZS. Since the samples in contact with soil contained very large macroparticles and rocks, the samples all required vacuum filtration through grade 601 Ahlstrom filter paper to eliminate the natural particles which are 3 to 4 orders of magnitude greater in size than the ones of interest in this study. This filtration had no effect on silver nanoparticles in the absence of additives (soil, seawater, etc). For the tests using environmental water samples, the colloidal silver was diluted 10 to 1 in the water in question.

RESULTS

The initial data in this section shows the properties of the colloidal silver used in these trials. This sample, selected at random, had 81% of its particles with an average size of 1.74 nm, and a zeta potential of –31.7 mV. The data in tables 1 through 6 show the results for the particles found in the fluid after the specified time of contact with the environmental samples in question. For example, in Table 1, when DI water was filtered through the soil samples, no nanoparticles could be found, but only large particles of the order of 300 nm or more.

Table 2 shows that, after only 15 minutes of contact with the soil samples, a decrease in zeta potential, and the smallest particles have increased to the 3 to 8 nm range, and they still represent 80 to 90% of the total.

Table 3 indicates that, after a full 7 days of contact with the soil, but kept away from sunlight, the nano particles have increased 3 to 8 times in size. In Table 4, these results are more dramatic, since the samples were all exposed to the sunlight for the 7 days, with the increases in size being 7 to 20 fold, and the smallest particles now representing only 30 to 40 % of the total.

To obtain the data in Table 5, the colloidal silver was left in contact with the environmental water sample for 21 days in sunlight. The particle sizes have significantly increased (3 orders of magnitude), with a corresponding drop in the zeta potential.

In Table 6, the samples were left in contact with the water samples instead of the soil samples for 7 days in the sunlight. The results of these tests show that each water sample also decreased the zeta potential and increased the particle size.

Properties of Colloidal Silver Used in Testing

Smallest Part., nm	Zeta Potential, mV	Total silver, ppm	Ionic silver, ppm
1.74	-31.7	21.40	9.60

Table 1: Deionized Water (DI)

Filtering Medium	Smallest Part., nm	Zeta Potential, mV	Total silver, ppm	Ionic silver, ppm
Sand	none found	–20.2	0.00	0.00
NJ Soil	none found	–1.5	0.00	0.00
PA Soil	none found	–31.7	0.00	0.00

Table 2: Colloidal Silver - 15 min. contact - 7 days later

Filtering Medium	Smallest Part., nm	Zeta Potential, mV	Total silver, ppm	Ionic silver, ppm
Sand	3.53	–20.6	1.14	0.00
NJ Soil	4.35	–22.2	1.57	0.20
PA Soil	8.30	–21.7	1.05	0.20

Table 3: Colloidal Silver - 7 days contact, no sunlight

Filtering Medium	Smallest Part., nm	Zeta Potential, mV	Total silver, ppm	Ionic silver, ppm
Sand	5.4	–15.7	1.27	0.00
NJ Soil	9.7	–20.8	0.56	0.00
PA Soil	14.7	–2.8	0.17	0.00

Table 4: Colloidal Silver - 7 days contact, sunlight

Filtering Medium	Smallest Part., nm	Zeta Potential, mV	Total silver, ppm	Ionic silver, ppm
Sand	11.3	–22.8	0.94	0.00
NJ Soil	26.9	–22.2	0.41	0.00
PA Soil	34.2	–21.2	0.35	0.00

Table 5: Colloidal Silver - 21 days contact, sunlight

Filtering Medium	Smallest Part., nm	Zeta Potential, mV	Total silver, ppm	Ionic silver, ppm
Sand	>2000	–12.7	0.54	0.00
NJ Soil	>1900	–6.1	0.24	0.00
PA Soil	>1700	–7.6	0.39	0.00

Table 6: Colloidal Silver - 7 days contact

Filtering Medium	Smallest Part., nm	Zeta Potential, mV	Total silver, ppm	Ionic silver, ppm
Tap water	113	–11.3	0.03	0.00
Sea water	631	–4.6	1.14	0.00
Well water	32.1	–15.7	1.47	0.20

While some of the changes in particle size seem small, one must realize that they represent large changes in loss of surface area and, since biological activity is proportional to surface area, this would correspond to large losses in biological effectiveness. In Figure 1, it can be seen that a change in particle size from 2 to 10 nm represents at least an 80% loss in surface area for the same weight of particles. This is a crude approximation, since the exact morphology of the particles is not known. To make these calculations possible, an assumption has to be made that the particles are spherical and the spheres are close packed.

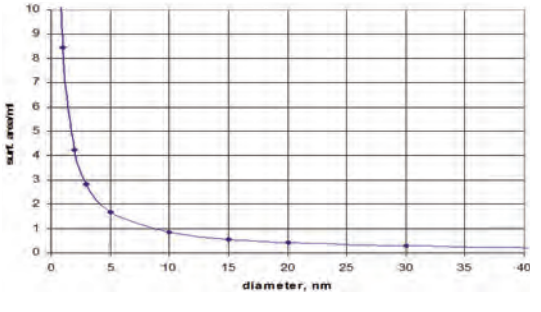

Figure 1. Loss of Area.

In a previous paper by F. Key and G. Maass,[3] the nature of a colloid was described as being a suspension of very small particles which are stabilized by having a diffuse double layer of solution ions around them. The charge acquired by these particles gives rise to a potential difference (i.e., mutual repulsion) between them that keeps them separate and stabilizes the colloid. This potential difference is called the Zeta Potential, and has been described in countless books on electrolytic effects in solutions. When the colloid is composed of nanoparticles, the task of preventing their agglomeration is not an easy one.

As the previous paper pointed out, if the zeta potential is more negative than –30 mV, then the mutual repulsion between particles is sufficient to keep them separate and stabilize the colloid. However, when the zeta potential is between –15 mV and 0 mV, the particles agglomerate and flocculation or precipitation occurs.

In a 1996 report by t M. Elimelech and A. E. Childress,[4] it was pointed out that for world average fresh water rivers, the concentration of common anions and cations across all normal pH ranges is sufficient to change the zeta potential range from about –10 mV

to +5 mV, promoting agglomeration of nanoparticles. In seawater, the agglomeration would be even more pronounced.

CONCLUSIONS

Theoretically, if a very large amount of silver nanoparticles from many sources were to be dispersed into the same part of the environment at the same time, it might be possible that the concentration of some good bacteria, as well as the bad bacteria, would be diminished, but this is not, at this time, considered a serious threat for the dietary supplement nanoparticles. The points to be remembered are as follows:

1. This report has demonstrated that silver nanoparticles will grow to biologically far less active "clumps" even if one dumps 27 litres of 20 ppm colloidal silver on each ton of soil. In practice, this is an enormously high quantity which could not be expected to be reached realistically.
2. In spite of the number of manufacturers producing silver nanoparticles or claiming to be silver nanoparticles, because of the low concentrations in which these products are sold, the total amount which could be released in any part of the environment would still be expected to be very low.
3. As shown by all the experiments above, nanoparticles do not persist as nanoparticles in nature for very long, but grow to harmless clumps of silver metal.
4. Silver nanoparticles are not water soluble, and, therefore, silver colloids will not release silver ions into the environment.

Once agglomeration of the silver nanoparticles occurs, the product is simply a harmless metal which has existed in nature from the beginning of our planet. Most people would not object to finding unreactive silver metal on their property.

REFERENCES

1. Science News, Apr. 9, 2008.
2. US Dept. of Agriculture, Handbook 296, 2006.
3. Key F, Maass G. "Ions, Atoms and Charged Particles", available at www.silver-colloids.com publications.
4. Elimelech M, Childress AE. Zeta Potential of RO Membranes by, contract No. 1425-4-CR-81-19290 US Department of Interior.