

# CELLFOOD<sup>®</sup> – A beneficial Colloid?

## Report of an Investigation into the Colloidal Nature of CELLFOOD

### Author

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### Background

CELLFOOD is a highly concentrated proprietary liquid formulation comprising a host of trace elements, minerals, enzymes, amino-acids, solvated (dissolved) oxygen and deuterated hydrogen. It is sold as a complete mineral and nutritional supplement to enhance the biochemical activities and functions of the body.

It has been suggested (1), based on the anatomy and composition of the CELLFOOD, that it may be a colloidal suspension functioning in a manner similar to, and compatible with, body fluids (such as blood, lymph, cerebrospinal, synovial and bone). The purpose of the present study is to determine the colloidal nature or behavior, if any, of CELLFOOD. The various mechanisms by which CELLFOOD may act, as a nutritional supplement, is beyond the scope of this report.

### Introduction

It is, perhaps, instructive, to first define exactly what constitutes “the colloidal state” and why such systems - colloids - are so important.

The overwhelming majority of manufactured products, that we deal with on a day-to-day basis involve, either in the final state or at some stage of their production, suspensions of particulate materials, emulsion droplets or air bubbles dispersed often at high volume fraction. Any suspension may exist in three distinct conditions depending upon the degree of subdivision of the discontinuous (internal) phase. For example, during the hydraulic transport of a coarsely ground limestone/water slurry through a pipeline, we can determine the technologically important physical properties of the system from the bulk properties of the separate phases and also by application of appropriate laws of mechanics and hydraulics; the chemical composition of the phases, as such, is unimportant. If, however, the same limestone-water mixture is subjected to grinding to reduce the particle size to below one micrometer ( $10^{-6}$ m), the system takes on characteristics unpredicted by the laws that previously applied. The suspension may behave as a semi-solid paste or as a free-flowing liquid depending, now, upon the presence of trace amounts of certain dissolved electrolytes that have no discernable effect on the original mixture. Further reduction of particle size to atomic/molecular dimensions, (say by dissolving with hydrochloric acid) will yield a system with behavior characteristic of liquid phases, i.e. a solution.

It is the intermediate systems – termed colloidal dispersions - that are of special interest because of their unique properties. But first, how, then, do we define the colloidal-size range? As a very rough guide, colloidal-sized particles lie within the range of one or two nanometers ( $10^{-9}$  m) to a few micrometers, i.e. from about the size of lactoglobulin to about the size of a small bacterium (such as staphylococcus). The red blood cell is about seven micrometers in diameter and is treated as a colloidal dispersion (2) and has long been used as a calibration reference material (3). Hence, while the lower size limit, at which we differentiate between a colloidal particle and a dissolved molecule, is understandably vague; the upper size limit is annoyingly arbitrary!

The colloidal domain, therefore, forms a critical interface between micro- and macroscopic regimes; it has been termed “the place where physics, chemistry, biology and technology meet” (4). The essential character common to every colloidal system is the large area-to-volume ratio for the particles involved (5). This can result in exceptional catalytic activity and chemical/biochemical reactivity; it directly impacts biomedical processes in, for example, controlled release of drugs after digestion, inhalation etc. The efficacy of such systems is dependent on the actual particle size distribution (PSD) of the particles and the chemical composition of the suspending fluid (6); this determines whether or not the particles will adsorb at, or permeate, a cell membrane (a phospholipid bilayer). From this it can be readily appreciated that not every colloidal system is “beneficial”. For example, natural water contains dissolved organic carbon (DOC), arising from the microbial and photolytic degradation of natural organic matter (NOM), creating, in effect, organic pollutants in the form of a colloidal dispersion. Current water treatment processes can remove only about 50% of NOM – a cause for concern by the World Health Organization. On a positive note, in recent times, the advent of “nanotechnology” has created excitement in a wide array of sectors in the scientific, medical and financial communities. Yet nanoscale materials are, by definition, colloidal systems.

## **Sample Preparation and Measurement**

When any material is dispersed in a fluid, the properties of the resultant suspension are dependent upon two fundamental parameters, namely:

- (i) The extent of the particle-fluid interface. This is characterized by properties such as the particle size/particle size distribution and particle shape and porosity, and
- (ii) The particle-fluid interfacial chemistry. This is characterized by the type and the degree of dissociation of any material surface functional groups in relation to the fluid chemical composition

There are many parameters that can be measured which reflect the extent of the interface and the interfacial chemistry. Two reliable and well-established parameters are, respectively, particle size and zeta potential; the techniques, that have been devised to determine them, are extremely diverse (7-9). The present study utilized an instrument based on dynamic light scattering for particle size measurement and phase analysis light

scattering (10) for determination of the zeta potential. All measurements were conducted by Mr. William Bernt (Particle Characterization Laboratories, Novato, CA) using a ZetaPALS instrument with the Particle Sizing Option (Brookhaven Instruments Corporation, NY).

Particle Size Analysis: The CELLFOOD concentrate was diluted using DI (VWR 18Mohm) water that had been filtered through a 0.1 $\mu$ m filter. The instrument was validated using a 92nm (+/- 3.7nm) PS latex suspension (NIST traceable) obtained from Duke Scientific, CA). The filtered DI water was also measured as a blank.

Zeta Potential Analysis: The CELLFOOD concentrate was measured as received and also diluted using DI (VWR 18Mohm) water. The instrument was validated using an NIST electrophoresis reference (SRM 1980) of 2.53 +/- 0.12 mobility units (equivalent to a zeta potential of 32.4 +/- 1.5 mV).

## Results and Discussion

The particle size results of the instrument validation and test sample are given in the Bernt (PCL) Report of May 14, 2001. The filtered DI water produced random scatter in the correlation function and a count rate too low for any analysis, consistent with the absence of any particles in the water. For the validation sample, it is clear from all methods of analysis of the raw data (Cumulants, NNLS and CONTIN) that the instrument passes validation. The particle size distribution (PSD) is clearly a narrow *unimodal* as shown by the polydispersity index of <0.01. The overall average particle size (PS), from all data, was calculated to be 91.2nm, well within specification.

Colloidal systems are generally, however, of a *polydisperse* nature, i.e. the particles in a particular sample vary in size and CELLFOOD is no exception. The method of cumulants gives an average PS of 2.45  $\mu$ m and the polydispersity index of 0.322 suggests a very broad PSD. This was confirmed by the NNLS and CONTIN analysis and, in addition, both algorithms resulted in a bimodal distribution with modal sizes at approximately 1.48  $\mu$ m and 6.63  $\mu$ m. Such a PSD is entirely consistent with the extremely complex compositional nature of CELLFOOD and the shape would, of necessity, impart unusual performance characteristics.

The zeta potential results of the instrument validation and test samples are given in the Bernt (PCL) Reports of May 15, 2001 and February 23, 2002. The filtered DI water had a measured conductance of 9  $\mu$ S, as might be expected and, since the particle size analysis did not detect any particles it is also not surprising that the measured zeta potential was close to zero (0.03mV). The instrument passed validation: the (average) measured conductance of the electrophoresis reference suspension was 1469  $\mu$ S and an average calculated zeta potential of 32.1mV - both values within specification.

The first test sample was the CELLFOOD concentrate run without dilution. The measured conductance was an amazing 200,000  $\mu$ S, undoubtedly due to the very high

concentration of electrolytes in the composition. The zeta potential was calculated to be  $-22.7\text{mV}$ , consistent with the fact that, under normal circumstances, biological cells tend to carry a net negative surface charge (or zeta potential). For example red blood cells suspended in isotonic saline solution (essentially 0.145 molar NaCl) have a measured zeta potential of approximately  $-14\text{mV}$ . Typically, micro-organisms have zeta potentials in the range of  $-5$  to  $-15$  mV. Now, the magnitude of the zeta potential always “decreases” (i.e., in this case, becomes **less negative**) with increase in electrolyte concentration. The conductance of the CELLFOOD concentrate is however, considerably larger than that for isotonic saline and yet the zeta potential is **more negative**. This is very unusual and it suggests that the colloidal particles in CELLFOOD may possess very special properties that could influence metabolic changes or alterations in blood flow properties and increase absorption of components from body fluids. It is well accepted that the magnitude and sign of the charge on a biological surface will influence its interaction with other surfaces or molecules.

The second test sample was the CELLFOOD concentrate diluted into filtered DI water at the rate of 8 drops to 8oz identical with the recommended daily dosage. As expected, the conductance now decreased to around  $3500\ \mu\text{S}$ . However, the zeta potential hardly changed. Indeed, it decreased slightly to  $-20$  mV, when it should have increased (i.e. become more negative). It is not possible, at this time, to speculate on why this should occur because the composition of the CELLFOOD is so complex. However, such behavior while desirable, is very unusual.

It is known that glacial waters contain mineral colloidal particles and a virtual “soup” of dissolved salts (electrolytes) and that drinking such water has a very positive benefit on the health and longevity of the users. In addition, it has been reported that the use of such waters in industrial formulations (such as cement) seems to dramatically improve performance characteristics. A detailed analysis of the surface and interfacial properties of glacial waters was able to substantiate some of the claims (11) even though the mechanisms involved could not be identified. Although it has not been possible to carry out a similar in-depth analysis of CELLFOOD, the similarities in colloidal nature lead this author to conclude that CELLFOOD is indeed, a very beneficial colloid.

## **Conclusion**

CELLFOOD is clearly colloidal dispersion. The shape of the particle size distribution and the magnitude of the zeta potential would suggest that the product would be compatible with body fluids. The data supports the notion that CELLFOOD should be beneficial as a nutritional supplement.

## References

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