A review of the evidence for Pacific Deep Ocean Minerals as a new complimentary dietary therapy for the prevention and treatment of Fatigue, CVD and Metabolic Syndrome

INTRODUCTION TO PROFILED DEEP OCEAN MINERALS (DOM)

Deep Ocean water (DOW) is a well-documented, safe, pure, stable and infinite resource with a high content of essential minerals including magnesium (Mg), calcium (Ca) and potassium (K) in their highly bioavailable ionic form. DOW is generally treated with micro filtration and reverse osmosis to desalinate and concentrate the magnesium and other minerals and trace elements at the expense of sodium chloride. We refer to this concentrated deep ocean mineral water as profiled deep ocean minerals abbreviated throughout the review as DOM.

THE STARTING MATERIAL – DEEP OCEAN WATER (DOW)

The evidence for profiled Deep Ocean Minerals to be incorporated into diet related therapies for the prevention and treatment of fatigue, cardiovascular disease and metabolic syndrome is reviewed in this paper. Whilst research is at a very early phase, results consistently recommend the potential therapeutic benefits of DOM.

The origin of life as well as our future has always been linked to the nutrient fertility of the Oceans. The process starts with the summer ice melt from Greenland, the water collecting minerals and trace elements during its journey to the ocean. The minerals make the water heavier and hence, this water naturally sinks to the ocean floor where it commences a 2000 year journey. It flows southwards down the Atlantic Ocean, moves around the African Cape and then inches north through the Indian Ocean and also into the western Pacific Ocean, coming close to land at Taiwan, Okinawa and Hawaii and then arching back south, towards the Antarctica where the changing sea water temperatures from the summer sun force the deep ocean water to the surface to feed the largest micro and macro food chain on our planet.

Surface sea water occurs to 250 meters. It is penetrated by sunlight and circulates in unison with the seasons and wind patterns.
Deep Ocean Water is found at depths of between 250 and 1500 meters. It is free of sunlight and life forms, characterised by its mineral density, cleanliness and trace elements. Deep ocean currents are driven by density and temperature gradients. The high mineral density is attributed to the depth related pressure and the change in temperature from 20°C+ at the surface to 8°C at 600 meters depth. We have seen that the studies done on DOM at similar depth and density will have similar mineral profile.

Very Deep Ocean Water has been discovered in a number of troughs in the Atlantic and Pacific Oceans. Depths can range for 1500 meters to 15 kilometres and life forms are supported where inner earth core pipes bring heat and minerals to the seabed floor.

There are three distinctly different ocean water systems with different functions and attributes. We are just starting to identify from recent of clinical research publications, the potential health benefits that could be derived from Deep Ocean Water. This paper provides a summary of recent research and discusses the innovation implications for sports nutrition and complimentary health therapies.

**PROFILING THE DEEP OCEAN WATER**

There are over 70 minerals and trace elements in Deep Ocean Water. In the table below, we have listed the main minerals in surface sea water, deep sea water, desalinated and standardised magnesium liquid ocean mineral water with Evian as a benchmark.

<table>
<thead>
<tr>
<th></th>
<th>Surface Water</th>
<th>Deep Sea Water</th>
<th>LOM-40K</th>
<th>LOM-90K</th>
<th>Evian Table Water</th>
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</thead>
<tbody>
<tr>
<td>Ca (mg/L)</td>
<td>406</td>
<td>422</td>
<td>359</td>
<td>39.0</td>
<td>80.0</td>
</tr>
<tr>
<td>Mg (mg/L)</td>
<td>1.220</td>
<td>1.230</td>
<td>43.400</td>
<td>96.100</td>
<td>26.3</td>
</tr>
<tr>
<td>Na (mg/L)</td>
<td>9.500</td>
<td>10.000</td>
<td>22.900</td>
<td>7.240</td>
<td>6.7</td>
</tr>
<tr>
<td>K (mg/L)</td>
<td>500</td>
<td>500</td>
<td>9.270</td>
<td>10.400</td>
<td>1.1</td>
</tr>
<tr>
<td>Li (mg/L)</td>
<td>0.13</td>
<td>0.1</td>
<td>4.4</td>
<td>11.7</td>
<td>0.006</td>
</tr>
<tr>
<td>SO4 (mg/L)</td>
<td>3.100</td>
<td>3.300</td>
<td>45.500</td>
<td>29.300</td>
<td>11</td>
</tr>
<tr>
<td>Cl (mg/L)</td>
<td>15.500</td>
<td>19.000</td>
<td>133.000</td>
<td>268.000</td>
<td>8</td>
</tr>
</tbody>
</table>

A more detailed breakdown of ocean minerals and trace elements can be found at http://pdobiotech.com/analysis

You will note that there is not a major analytical difference between surface sea water and deep sea water. However clinical trial results comparing the effect of surface sea water to deep sea ocean water, consistently show a statistically significant difference. This is attributed to the presence of organic matter and contaminants in surface sea water which are not present in deep sea water. We have listed two standard desalinated products. LOM-40K is a liquid ocean mineral, concentrated 60 times and having a minimum of 40K ppm magnesium. This profile is typically used for rehydration and sports related activities. LOM-90K is also a liquid ocean mineral, concentrated 350 times and having a minimum of 90K ppm magnesium. This profile is typically used for therapies requiring high concentrations of magnesium. These two standardised products have been typically used in clinical trials.

**FINDING THE MINERAL DIET FOR OPTIMUM ENERGY - ATP**

The human body constantly needs macro minerals and micro trace elements that can be found in DOW to maintain its energy management. We particularly need soluble minerals or electrolytes to help us maintain optimum cellular fluid levels and keep our body’s pH in balance. Deficiencies in macro minerals and micro trace elements can lead to pre-mature ageing, immune dysfunction and...

1 (Mitsuhiko MIYAMURA 2004)
susceptibility to cardiovascular related diseases. Regular dietary consumption of the optimum ratios of macro minerals can greatly increase vitality and one’s quality of life.

Macro minerals and trace elements found in deep ocean have three important functions:

1. Provide the structure to our organs, tissues and bones – calcium, phosphorus, magnesium, fluorine, phosphorus and sulphur, all present in DOW.

2. The electrolyte form facilitates body fluid activity in tissues to maintain fluid balance, acid-base balance, membrane permeability, tissue irritability (including nerve transmission and muscle contraction) - sodium, potassium, chloride, calcium and magnesium in blood, all present in DOW.

3. Magnesium alone, catalyses over 300 enzyme and hormone reactions.

Let us briefly review the major macro minerals present in deep sea water. Research shows that we should profile these minerals to better match our daily nutrient requirements.

**Magnesium** is essential to our existence, a co-factor to hundreds of enzymes in our bodies and is fundamental to our nitric oxide energy production (adenosine triphosphate ATP), protein synthesis, ion transport and cell signalling. Magnesium deficiency is associated with cardiovascular disease, osteoporosis, metabolic syndrome, hypertension, diabetes mellitus type 2 and fatigue syndromes.

One Magnesium molecule can hold up to 80 water molecules, compared to calcium and other metallic ions that can only hold 4 to 8 water molecules. This makes it a strong re-hydrant and a natural moisturizing factor (NMF) because it simply absorbs and keeps many water molecules in motion. Magnesium has already been shown to be beneficial for sports nutrition, rehydration, cosmetic applications, bone health as well as cardiovascular functions.

**Potassium** is the main positive ion in our cells that maintains fluid and electrolyte balance. It moves passively through pores in the cell membrane, conversely to sodium, to create the sodium-potassium pump with the resulting energy effect which transports proteins. Potassium is important for reduction of hypertension and blood pressure. It needs to be positively profiled into our diets.

**Sodium Chloride** is one of the main compounds in Sea Water. Sea water is saturated with NaCl (Sodium Chloride) also known as table salt. Sodium binds with chloride and bicarbonate to hold the correct balance of positive and negative ions in our body fluids and tissues. In combination with Calcium and Potassium, it stimulates muscle contraction and helps to keep calcium and other minerals soluble in the blood as well as stimulating the adrenal glands. Perspiring due to excessive heat or sports activity will lead to a loss of sodium chloride which will need to be replaced to achieve rehydration. Conversely, too high Sodium Chloride intake in the diet can lead to excess water in the tissue which places additional strain on the kidneys.

**Calcium** is necessary for health and longevity. Like sodium chloride, the wrong amount can be harmful. Calcium needs magnesium to be absorbed and solubilised into your bones, blood and muscle tissues. Too much calcium and too little magnesium can result in hardening of the arteries, kidney stones and muscle spasms. Most people have an over consumption of calcium and an under consumption of magnesium. The modern calcium dietary recommendation is to increase levels of magnesium to enhance the absorption of calcium.

**Micro Minerals and Trace Elements** are plentiful in deep ocean water. These are needed by the body in very small amounts; often less than one hundredth of one percent of body weight, yet they are still critical to facilitate biological functions and for the absorption of vitamins. See www.pdobitech.com for a complete list of micro minerals and trace elements.

**THE APPLICATIONS FOR DEEP OCEAN MINERALS AND THE CLINICAL EVIDENCE**

Sea water has had a long history of therapeutic use, referred to as Thalassotherapy, originating from the Greek word thalassa. Both the Greeks and the Romans used the therapeutic effects of sea water for relaxation, regeneration and stimulation. Books on the healing power of sea water first appeared in the 17th Century and until the early 20th Century, seaside holidays were firstly therapeutic and secondly recreational holidays.

In 1897, René Quinton published the first comprehensive scientific thesis advocating the medical use of sea water in his book, “Seawater Organic Matrix, 1904”. He discovered the similarity between nutrients in ocean water and our blood. He noted that the ratios of minerals in both fluids were similar with the exception of sodium chloride, which he adjusted. Quinton selected sea water from regions which also contained micro algae. Today, we are able to access deep ocean minerals and with new desalination technology, adjust mineral ratios to broaden and better target health applications. Companies often refer to this a balancing deep ocean water.

Most of the more recent scientific research into the benefits of deep ocean water has been conducted in Japan, Taiwan, Korea and Hawaii. It falls under the following categories.
As background, elevated concentrations of blood lipids, particularly Low Density Lipids (LDL) cholesterol, are a significant risk factor for atherosclerosis and coronary heart disease. Thus, a diet that reduces or eliminates these products lowers total and LDL cholesterol and triglycerides.

Hyperlipidemia is the term describing too many lipids or fats in the blood. Treatment is usually a combination of a healthier diet, exercise and medication in extreme cases. Hyperlipidemia is an important risk factor for atherosclerosis, particularly if combined with smoking and diabetes, leading to a higher incidence of cardiovascular disease.

In 2003, Japanese researchers published their findings regarding the pharmacological activity of DOM directly influencing the serum lipid values of cholesterol fed rabbits. In 2004, the group also published new findings showing changes to LDL cholesterol in dietary induced hyperlipidemia rabbits, comparing surface sea water, deep sea water (DSW) and a control group. The plasma LDL cholesterol level was lower in the DSW group than in the surface seawater group. Glutathione peroxidase GPx activity was significantly higher in the DSW group than in the control group, while there was no difference between the surface seawater and control groups. The level of LPO was also significantly lower in the deep seawater group than in the control group. These early findings suggested that the DSW could be useful for the prevention of hyperlipidemia and arteriosclerosis compared to the surface seawater, and it was found that reduction of the LDL cholesterol level and enhancement of (GPx) activity were involved in these effects.

In 2008, a Japanese research group again used Hypercholesterolemic Rabbits to examine changes due to DSW diet on cardiovascular Hemodynamics (blood flow and pressure). Systolic, diastolic, pulse and mean arterial pressures and total peripheral resistance were significantly lower in the deep sea water group than in the control group.

FATIGUE SYNDROMES
We all experience periods of physical and mental fatigue. It is a normal result of working, mental stress, overstimulation and under-stimulation, jet lag or active recreation, depression, and also boredom, disease and lack of sleep. It may also be caused by mineral or vitamin deficiencies. Recent studies are showing that DOM could help reduce the time and physical discomfort associated with fatigue.

In 2009, scientists at the National Taiwan Ocean University, Keelung, Taiwan, published the first notable wistar rat treadmill fatigue study. Researchers used desalinated deep ocean water processed with ultrafiltration and reverse osmosis to increase magnesium levels and hardness. The water was sourced from the East Coast of Taiwan. The Study showed that the DOM experimental groups were significantly better than the control group with regards exhausting time and the ratio of lactic acid elimination to lactic acid increment. Summarizing the results, the researchers suggested that endurance, adaptation for exercising load and accelerating elimination in fatigue of rats could be improved when fed with DOM of higher hardness and quantity. In 2014 scientists at the Hung Kuang University, Taichung, Taiwan, published a gerbil animal trial, endorsing the findings of the wistar rat trial and again demonstrating that profiled deep ocean water, significantly improved exercise performance in gerbils subjected to treadmill exercise.

In 2013, Researchers at the department of Sports Sciences, Taipei University conducted a randomised double blind placebo controlled cross-over human study to evaluate the effect of Deep Ocean Water on time recovery from a fatiguing exercise conducted at 30°C. DOM supplementation resulted in complete recovery of aerobic power within 4 hours. Muscle power was also elevated above placebo levels within 24 hours of recovery. Increased circulating creatine kinase (CK) and myoglobin, indicators of exercise-induced muscle damage, were completely eliminated by DOM in parallel with attenuated oxidative damage. Researchers concluded that the results provide compelling evidence that DOM contains soluble elements, which can increase human recovery following an exhaustive physical challenge.

CARDIO VASCULAR DISEASE PREVENTION
A series of studies over the last 11 years show potential application of DOM for use as a dietary therapy for prevention and complimentary treatment of CVD.

2 (Shang-Ta WANG 2009)
3 (Wang M.-L. 2014)
4 (Chien-Wen Hou 2013)
5 (Rinsho 2002)
6 (Saburo YOSHIOKA 2003)
7 (Mitsuhiko MIYAMURA 2004)
8 (Shin-ichiro KATSUDA 2008)
The first human trial was conducted in Japan in 2008 with 16 male volunteers examining the effect of Nigari (natural salty sea or lake water) standardised on magnesium in a two way, randomised cross over study. The healthy subjects were given a fat load test prior to measuring effect of postprandial (after meal) hyperlipidaemia. They found that Mg supplementation reduced and delayed the postprandial serum and chylomicron TAG responses after fat loading. The data indicates that Mg supplementation may contribute to preventing the atherogenic process in healthy subjects.

Next we see a series of research publications from Taichung University, Taiwan. In 2011, Mice trials again confirm similar results to earlier Japanese findings and conclude that electro-dialysed DOW benefits high cholesterol dietary mice and recommend that standardised deep ocean minerals should be pursued as a dietary food ingredient for cardiovascular health. Similar results at the Taichung Medical University were also published in 2011 for hamsters. In 2012, Taipei, a major human trial with 42 hypercholesterolemic volunteers were randomly divided into three groups: reverse osmotic (RO) water, DOM (Mg: 305mg/L, hardness 1410ppm), and magnesium-chloride fortified (MCF) water (Mg: 386mg/L, hardness 1450ppm). Serum low-density lipoprotein- cholesterol (LDL-C) was also decreased by DOM. Further, total cholesterol levels of subjects in the DOM group were significantly lower than those in the MCF water or RO water groups. In 2013, Taichung University researchers published an extended rat trial The study indicated that 0.1 × DOM, 1 × DOM and 2 × DOM decreased the systolic and diastolic pressures in spontaneous hypertensive rats in an eight-week experiment. DOM has been shown to reduce serum lipids and prevent atherogenesis in a hypercholesterolemic rabbit model. The results demonstrated that DSW significantly suppressed the serum cholesterol levels, reduced the lipid accumulation in liver tissues, and limited aortic fatty streaks.

In 2014, Qingdao Ocean University, China, published a paper showing when DOM was added to HepG2 cells, it decreased the lipid contents of hepatocyte through the activation of AMP-activated protein kinase, thus inhibiting the synthesis of cholesterol and fatty acid and recommended further investigation for treatment and prevention of hypolipidemic and other lifestyle-related diseases.

From the CVD research to date, we can note a potential complimentary dietary application for DOM which could positively impact cholesterol, raise HDL levels, reduce LDL levels, improve blood flow, reduce blood pressure and potentially reduce risks of atherosclerosis and subsequent cardiac failure.

METABOLIC SYNDROME

The USA National Institute of Health identifies metabolic syndrome as a group of five risk factors that can increase your chance of developing heart disease, diabetes, and stroke. The five risk factors include:

- A large waist line
- A high triglyceride levels
- High blood pressure (greater than 130/85)
- Low levels of good cholesterol, or HDL
- High fasting blood sugar levels (insulin resistance)

Having one of these risk factors does not mean that you have metabolic syndrome. Having three or more of these factors will result in a diagnosis of metabolic syndrome and will increase your risk of health complications even further.

We have already noted that DOM could have a positive impact on cardio vascular health. The research findings from the Bio-Medical Research Institute, National University Hospital, Daegu, Korea, extend the possible dietary use of DOM to a treatment for metabolic syndrome. Korean researchers in 2008, reported that DOM could potentially be used as an anti-obesity agent by inhibiting adipocyte differentiation mediated through the down-regulated expression of adipogenic transcription factors and adipocyte specific proteins. In 2009, the same Korean researchers published a further study on the anti-obesity and anti-diabetic effects of DOM in ob/ob mice. The control group received tap water and the experimental group received DOM of hardness 1000 for 84 days. The DOM fed group compared to control group, reported 7% body weight decrease, reduced plasma glucose levels by 35.4% and significant increase of glucose disposal after 84 days. The researchers suggest that the anti-diabetic and anti-obesity activities of DOM were mediated by modulating the expression of diabetes and obesity specific molecules. Taken together, these results provide a possibility that continuous intake of DOM can be of dietary therapeutic value for treatment of obesity and diabetes. In 2013, a further diabetes induced mice study was conducted to establish dosage regimes. The researchers concluded that DOM provide a novel activator for glucose uptake.

9 (Yoshimi Kishimoto 2009)
10 (JUL-HONGSith 2011)
11 (Chin-Lin Hsu 2011)
12 (ZY Fu 2012)
13 (MJ Sheu 2013)
14 (Shan He 2014)
15 (L. S. Hee Sun Hwang 2008)
16 (H. A. Hee Sun Hwang 2009)
17 (Byung Geun Ha 2013)
CONCLUSION
This research review paper has been written to provide scientists, government health policy advisors and health care practitioners with a summary of the potential therapeutic applications of DOM for the treatment of fatigue, CVD and metabolic syndromes. Profiled Deep Ocean Minerals are free of side effects, safe and an inexpensive option. We recommend that government and university research grant officers continue to support this new dietary direction.

BIBLIOGRAPHY


