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Review Article

Salts and Calcium: Masquerades in Nutrition - A Discussion

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Abstract

Modern life has brought us humans to such a dependency on external things that many neither know where those things are from nor how they are made or transformed.

In this review, it was attempted to discuss the different products concerning the simply extracted sea salt to the modern and highly processed "table salt" and their different degrees in adequacy of consumption and human physiology.

Then the discussion proceeds to the element calcium and its various possible chemical forms, both organic and inorganic compounds, in relation to bone's healing and/or bone's homeostasis. Then, possible relations between some anti-nutrition habits and their power to seriously damage the kidneys or the whole emunctory system as well as the bones, are addressed.

This review is intended to shed some light on proper directions to Dietetics and Medical Science professionals, and also layman in general, in the use and abuse of these substances and how to take back your power by choosing based on scientific knowledge.

Keywords: *Salts; Calcium; Nutrition; Bioelectricity; Processed Sugar; Soft Drinks; Osteoporosis; Trace Elements*

Salts

Salts and our physical bodies

Our physical bodies are composed of 75 - 90% water and are electric. Electrical currents are vital to life and also in healing processes (piezoelectricity generating electric potentials in bones and in healing broken ones [1]; acupuncture (bioelectricity [2]), which has been used in Chinese Medicine for thousands of years [3]).

Piezoelectric substances are capable of transducing mechanical energy into electric current. Indeed this bioelectricity in our bodies is one of the principles of being alive and healthy [4].

Life on Earth had its origin in the oceans and we are all made of water and minerals in the most intelligent and specific ways [5]. Dr Robert Otto Becker has studied what he called "The Body Electric" for many years [6].

What makes our bodies capable of generating electricity then?

Exactly water and electrolytes through electrochemical processes are generated by the displacement of charged ions across membranes. (Not caused by electrons, as the human body generates electricity through the movement of charged ions, creating differences in electrical potentials according to their concentration in and out the cells - known as Action Potentials) [7,8]. These action potential processes, in their entirety, rely on the dynamic balance of ion gradients and on the activity of ion channels and pumps (Na^+/K^+ ATPase pumps, which restores ionic balance after each action potential). Very important in neurons, nevertheless beyond them, action potentials also occur in cardiac muscle cells and some endocrine cells, hence their importance in various physiological systems [9].

Many are the bodily functions that work on these electrical pulses generated and travelling along the cell membranes for the accomplishment of muscle contraction, brain activity and heartbeats [10]. Also, water can only pass the cell membranes if it has salt ions dissolved in it, getting through the cells by the osmotic pressure effect [11].

But then if the above physiological processes and others absolutely need salts and adequately hydration, moreover adequately provided with electrolytes in water and in proper concentrations, we need to consume both in order to replenish our bodies after losing the most soluble ones through natural daily elimination. So, we humans, can neither live out of salt nor water. They go together.

Sea salt is composed of around 84 minerals (in major and in trace concentrations), e.g. the ions of - sodium, chloride, magnesium, calcium, potassium, iodine, iron, manganese, zinc, and selenium, silicon, boron, lithium, beryllium, sulfur, manganese, cobalt, nickel, copper [12-14].

The masquerade lies in the fact that not all salts are Nature's original salts and not all are healthy.

There are 2 kinds of salts, if I may say so - the natural one and the processed one (AKA table salt - very toxic [14]). Natural salts are from sea water, either from evaporation (sea salt or marine salt) or from alkaline extraction in an specific process to obtain a product known as ORMUS [15,16].

But why is table salt toxic if it comes from sea salt?

Table salt

Well, that is another story. To answer that we need only to follow the money... There is a need in industry for NaCl (sodium chloride), the major constituent of sea water. The many industrial uses for the chemically pure NaCl (obtained from seawater or mineral deposits, using either one of the following processes or more like natural freezing, solar evaporation, crystallization, and electrolysis) [17], are in the production of fertilizers, plastics, chlorine dioxide, sodium hydroxide, sodium chlorate, in the Solvay process to produce sodium bicarbonate, sodium hypochloride, manufacturing of rubber, textiles and pharmaceuticals, in the oil and gas sector, in producing PVC plastics, soaps and disinfectants, to regenerate ion-exchange resins in water softening systems and in the removal of hardness in waters, as a preservative in food processing, as a stabilizer in construction materials like concrete and many others [18]. The astounding percentage of 93% of processed salt goes to these industries, while 7% goes to the food market.

The trace minerals that are in the sea water and consequently in the sea salt, when industrially processed, are collected in the process of concentrating NaCl (= brine [19]) and separately sold, as they are very valuable, generating an extra revenue for the industries.

From the average of 84 ions present in the sea salt, the final industrial product will only have 2 - Na^+ and Cl^-. Many times obtained under processes that involve heat and elevated pressure, the original sea salt is denatured.

Not only that. The addition of both anti-moisture and anti-caking agents to the final already denatured product, transforms it into a completely adulterated and misrepresented salt, making the table salt toxic to our bodies [20]. (Additives added are fluoride, synthetic iodine, and the anti-caking agents are potassium aluminium silicate, sodium aluminium silicate, calcium aluminium silicate... [21]).

When this processed (ultimately highly concentrated in NaCl) salt ends up in our table, after some time, it wreaks havoc in our bodies. As the concentration of NaCl in sea water is very different from the one in the table salt, the body has to deal with a peak of sodium overload on a daily basis, finally causing a lot of bodily disfunctions. The table salt is like the refined sugar, most of their original nutrients are missing in the extensive processing that strips away most of their original components.

Another masquerade concerning salt is that if the final product in the supermarkets states in its lable many ingredients, anti-caking and other additives in disguised symbols with letters followed by numbers, it is definitely processed. Even mislabeled as "sea salt" it is, in reality, a highly processed one.

It is not the sea salt's fault if some professionals do not know the huge differences between these 2 type of "salts" - Nature's and industrial's. Not being in the know of these concepts, they not only advise banning the use of salts but also do not explain the real importance of both the proper product and amount for consumption to persons seeking advices in Nutrition. Both practices are a time bomb for health problems.

The sea salt, when consumed moderately, not only is essential to the biophysics of our bodies, but also sees that the cells are adequately hydrated. In the absence of natural salt, the water has a difficult time entering the cells. Also many other electrophysiological processes cannot perform well without the action potential generated by the electrolytes (salts) in our bodily fluids [22].

The Himalayan salt

And yes, the Himalayan (original) pink salt is from sea water, from an ancient ocean that once borne the Himalayan sea salt we harvest today in Pakistan, near the Himalayan foothills (Refer to figure 1a and 1b). There are plenty of counterfeit products however (Refer to figure 1c): Either by dyeing regular table salt, the product then presenting an unnaturally bright pink; or having an uniform colour, and a finer texture compared to the natural, or still, presenting some uneven crystals of the genuine Himalayan salt.

Figure 1: *a) Real Himalayan salt crystals. (By Lordtct - Own work, Public Domain, https://commons.wikimedia.org/w/index.php?curid=7417996). b) Himalayan course salt. (By Ivar Leidus - Own work, CC BY-SA 4.0 https://commons.wikimedia.org/w/index.php?curid=97103074). c) Red rock salt from the Khewra Salt Mine in northern Pakistan, falsely known and sold as Himalayan salt. The chemical composition of this so called "Himalayan salt" includes 95-96% sodium chloride, contaminated with 2-3% polyhalite and small amounts of ten other minerals. The pink color is due to iron compounds. (By Hubertl - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=38767207).*

Other very important aspect to be considered before blaming natural salts to promote high blood pressure is that there are plenty of scientific works stating the inequivocal relation between insulin resistance, as the ultimate culprit, and blood high pressure. Insulin resistance, in a nutshell, is acquired after the body is so exhausted of dealing with excess sugar (in a combination of other lifestyle factors), that cells become resistant (non responsive) to insulin. This impaired insulin sensitivity prevents the regulating of blood glucose (sugar) levels. Not only diabetes will be the end result, but also the kidneys will be impaired, incapable of dealing with the situation. In this way, insulin resistance can increase blood pressure by causing the kidneys to retain more salt and fluid, and this elevated blood pressure, in turn, damages the kidneys over time. The kidneys' ability to filter waste is reduced, which can lead to further hypertension and kidney damage, a cycle that can eventually progress to end-stage renal disease [23,24].

The role of refined sugars in all chemical and industrial forms

Refined and processed sugar is also another masquerade in Nutrition, as same as the refined and processed salt, both are toxic to our human Biochemistry. Almost every single industrialized product for the food market uses refined sugar, either as the refined product itself or the refined fructose and its byproducts (high-fructose corn syrup, maple syrup, dextrose, fructose, and crystalline fructose, inverted sugar or inverted syrup) all meaning "highly processed sugar", many different names for the same toxic product [25-28].

Fruit content in sugar comprises natural "oses", primarily fructose, glucose, and sucrose (sacarose). Notwithstanding, fruits - consumed as such, have nutrients (enzymes, vitamins, antioxidants, minerals) within them and slow release capacity (provided by the fibers) in making them available including the sugar, and promotes a better digestion and a delayed release of energy. Not a spike release of sugar and consequently a spike of insulin when any form of refined sugar is consumed. This spike release of sugar in the blood stream is what will eventually end up causing insulin resistance. Refined sugar consumption is one of the responsible for the epidemy of blood high pressure, not natural salts in adequate few quantities consumption [27,28].

Partial conclusion

The professionals of Nutrition can now throw a critical gaze over this information and the facts and myths on the essentiality of natural salt and its proper consumption. Also can go look for the references below and then decide what to do in your daily professional and private lives when advising their clients or family on salt and sugar uses.

Calcium

Calcium and osteoporosis - the myth and why

Calcium is a metal in its elemental form, and in the stable ionic form has 2 electrons missing, so the ion derived from metal calcium is represented by ions Ca^{2+}. Rumour has it that calcium deficiency is linked to osteoporosis as the main or even the only culprit.

"Bones (bone matrix; bone cells - osteoclasts, osteocytes and osteoblasts - and calcified extracellular substance; those are their major constituents) are a natural composite material whose main components are mineral and organic matrices" [29].

Essentiality of minerals

Trace minerals (ions) are essential in the maintenance of bone quality. The metal ions act as metalloenzymes in the synthesis of collagen and other proteins which constitute the bone structure. Bone cells are regenerated in a complex process involving at least 10 years and nutrition is critical over the whole life span of an adult.

The nutrition needs for healthy bones include calcium and phosphorus (mainly bone apatite), vitamins K_2 and K_1, and vitamin D_3 and minerals as zinc, copper, fluorine, manganese, magnesium, iron, selenium and boron, in ionic forms. Selenium as a trace element in the human body is necessary in enzymes and proteins (selenoproteins), and important for skeletal development presenting the second highest percentage in bones (16.0%), after skeletal muscles (27.5%). Being necessary microelement, nonetheless, approximately 1 billion people reportedly have selenium deficiency worldwide. Selenium is largely found in soils as organic and inorganic forms as selenide, selenate, and selenite, and is absorbed by humans as organic selenium compounds (in edible plants and seeds) better than as inorganic ones [30-33].

Bones are highly mineralized tissues containing, in its intercellular matrix, inorganic crystals (hydroxyapatite) and other organic matter - type I collagen mainly - as connective tissues [33].

Osteoporosis, a disease reducing bone mineral and changing bone microarchitecture, is a multi-factorial condition, including nutrition habits. In [34] it is stated that "several trace elements including zinc and copper are essential for normal development of the skeleton in humans and animals".

Zinc and its role on human homeostasis and immunity

Zinc is essential and very important in catalytic, regulatory and structural roles and in immune maintenance and regulation by participating in DNA synthesis and cell division, among other important functions. Its deficiency or total lack makes a person more vulnerable to infections as a result of immune dysfunctions specially in the elderlies [35-38].

Zinc needs in humans go far beyond the aforementioned processes. As a micronutrient, zinc is essential to bone's tissue normal development and maintaining homeostasis. It is related to the maintenance of the immunity in stress either chronically or for a relative large period of time. Zinc is depleted from our bodies being completely finished if not supplemented, in burnout episodes. This happens by prolonged stress causing emotional, physical, and mental exhaustion, which activates the hypothalamic-pituitary-adrenal (HPA) axis, resulting in elevated cortisol levels, which in turn can downregulate zinc concentrations in the blood [39,40].

"Zinc is not only a component of bone tissue but is also involved in the synthesis of the collagen matrix, mineralization, and bone turnover" [41]. Zinc in bone metabolism is one of the most important nutrients and is involved in the proper functioning of the skeletal system. Zinc also plays a critical role among steps in bone metabolism, bone tissue formation, inhibiting bone resorption, and bone remodeling [41 - and references cited therein].

Copper essentiality

Copper, the third mineral mainly found in the human body (after iron and zinc), is however, ubiquitous in all cells. Copper participates in oxi-reduction reactions, in disposing and removing free radicals from the body, and is a functional component in many essential enzymes - the copper enzymes - for instance, the cytochrome C oxidase, which plays an important role in cellular energy, utilized by mitochondria to create energy and store in the ATP molecules [42,43].

It is important to state that aluminium, lead, cadmium and mercury in [33], says: "Both lead and cadmium are nephrotoxic and can disturb vitamin D metabolism. Cadmium has been shown to induce kidney damage and osteoporosis/osteomalacia at long-term high-level exposure. A negative association between cadmium dose and bone mass has recently been detected in both occupationally and environmentally exposed people at relatively low cadmium exposure".

Cadmium also has an hepatotoxic activity, and aluminium is capable of being introduced in the apatite crystals. Both elements have a deleterious effect in the whole bone structure [34,44].

For a review on essential metal ions, toxic metal ions and how to detox from environmental and occupational exposure refer to [45].

"Modern facilities", like using plastics to "microcook", aluminum pots, fast food with highly processed products containing ingredients like processed salts, processed sugar, conservants, colorants, MSG (monosodium glutamate) sodas, artificial sugars, ... certainly depletes us humans from the minerals needed to maintain homeostasis.

Also, it has to be considered that minerals are depleted from our bodies in high dietary acid load (DAL) for a long period of time, incurring even in different degrees of osteoporosis. Many studies have shown an imbalance in the acid-base system and osteoporosis (bone density and structure) [46 - and references therein].

As the body desperately needs to neutralize the excess acidic load it is receiving, it uses mainly calcium, magnesium, potassium and sodium, and eventually zinc and manganese ions to overcome this aggression. Buffer systems present in the body can do this job to a certain extent. The primary intracellular buffer systems include proteins and phosphate ions. Proteins, due to their amino acid side chains with acid and basic groups, can act as both proton donors and acceptors, contributing significantly to buffering capacity-accounting for two-thirds of the buffering power in blood plasma and most of the buffering within cells. "Protein buffer systems work predominantly inside cells. The kidneys help control acid-base balance by excreting hydrogen ions and generating bicarbonate that helps maintain blood plasma pH within a normal range" [47] (refer to equations 1 to 3 below).

The blood has a strong acid-base regulatory system - the acid-base buffer systems - which involves the kidneys and lungs to maintain the blood plasma pH range strictly between 7.35-7.45. Below pH 7.35 the blood is in "acidic" condition, and above 7.45, in alkaline condition.

Acid-forming foods

The importance here is to identify two different situations discussed below.

First: Acid-forming foods, not acidic foods, which in some cases, only present in their original form and acid pH (below 7). What should be avoided are the acid-forming foods: They are those processed, rich in sodium and chloride (processed salts) and in refined (processed) sugars, and too much of the following foods: red meat, poultry, fish, dairy, eggs and alcohol in any amount. Some naturally acid foods like lemon juice, for instance, are not acid to the body, for it leaves behind alkaline byproducts after being digested.

In figure 2 it is seen an schematic diagram of a pyramid showing some examples of foods and their potential-renal-acid-load (PRAL) indexes. Positive indexes in this diagram are linked to acidic content, while negative PRAL indexes, indicate alkaline content. This will mostly affect the pH of the cells (normal pH between 6.5 - 7.5), but not much the pH of the blood. So, although a minor problem still counts, as the body will draw alkaline ions to set the pH to homeostasis values in case of imbalances.

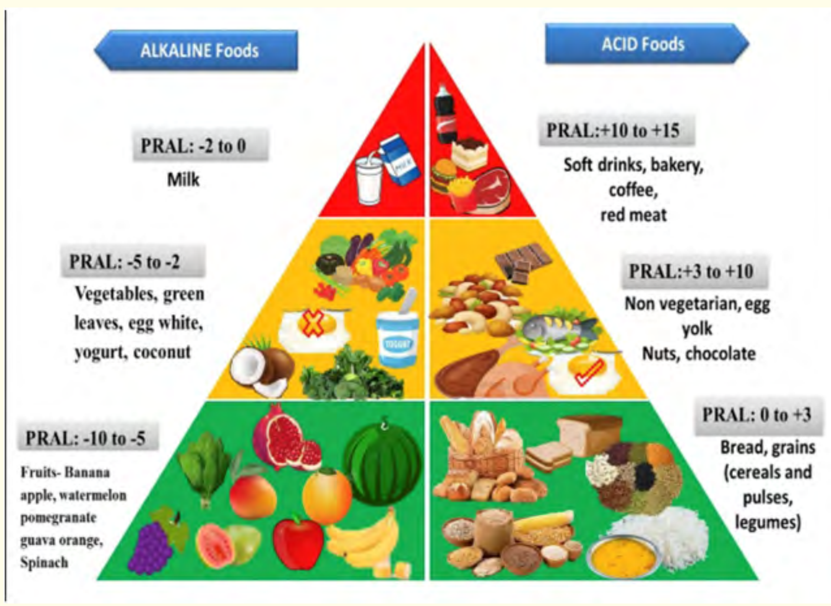

Figure 2: *Indian food pyramid scheme representing PRAL (potential-renal-acid-load) values for various Indian diet, with left hand side showing some alkaline foods (PRAL <1 or =0), and right hand side depicting some examples of acidic foods (PRAL values >1). Licensed by Creative Commons (https://creativecommons.org/licenses/by-nc-sa/4.0/).*

Second: However, the second situation involves huge loads through ingestion of, for instance, highly acidic sodas (soft drinks), specially the colas [48]. In these beverages, phosphoric acid is added to make them acidic, and CO_2 to make it sparkling, and eventually a lot of sugar. Considering addition in a 355 mL (12oz) can of 50 to 60 mg of phosphoric acid, plus 39g sugar (sometimes derived from high fructose corn syrup, highly processed) knowing that the daily recommended consumption of sugar was set to 27g (women) to 37.5g (men) according to American Heart Association); Or instead of sugar, addition of synthetic sweeteners (aspartame, produced by components made using genetically modified *E. coli* bacteria and releasing methanol as one of the byproducts after digestion, and/or acesulfame also from chemical synthesis, both made in laboratories), plus 40 mg of sodium ion, and finally preservatives and colorants. This is your daily cola soft drink, in one single can of 355 mL [49].

The study in [50] shows that the consumption of "diet" drinks not only decreases the pH in the serum but also, phosphoric acid in combination with aspartame "may lead to bone demineralization" and as a final result, "a decrease in bone density". In this study, the increase in acidity is claimed to be due to partial hydrolysis of the aspartame into aspartic acid, adding to the already load of acid due to phosphoric acid. But not only. Regular exposure to phosphoric acid, according to the same study, makes the stomach to produce less chloridric acid, thus impairing the absorption of minerals, thus aggravating the demineralization condition in the body further leading to poor bone density.

Human blood buffer systems

The human body relies on 3 pH buffer systems to maintain this very narrow range of healthy pH values in the blood [24]. One is the phosphate buffer, the second, bicarbonate buffer and the third, made of organic molecules (protein buffer system - albumin and globulins, and hemoglobin). The first pH buffer system regulates the blood pH according to the reversible reaction (1a):

$H_2PO_4^-{}_{(aq)}$ <=> HPO_4^{2-} + $H^+_{(aq)}$ $pK_{(25^oC)} = 7.21$ (1a)

$H^+_{(aq)}$ + $H_2O_{(aq)}$ <=> $H_3O^+_{(aq)}$ (1b)

Hydrogen ion + water <=> hydrated hydrogen ion.

($H_2PO_4^-{}_{(aq)}$ is generated when phosphoric acid is in a pH value > 2.14 and generates a proton and dihydrogenphosphate ion, according to reaction 1c.

Reaction 1c shows the reaction of phosphoric acid generating the ion dihydrogenphosphate ($H_2PO_4^-{}_{(aq)}$) which is the one participating in the buffer system, in a reversible equilibrium with HPO_4^{2-} and $H^+_{(aq)}$ (equation 1a). Reaction 1b shows the proton hydrated, in aqueous solution (another way of stating the hydrated proton).

$H_3PO_{4(l)}$ + $H_2O_{(l)}$ <=> $H^+_{(aq)}$ + $H_2PO_4^-{}_{(aq)}$ $pK_{(25^oC)} = 2.14$ (1c)

Phosphoric acid + water <=> hydrogen ion + dihydrogenphosphate

$H^+_{(aq)}$ + $H_2O_{(aq)}$ <=> $H_3O^+_{(aq)}$ (1b)

Hydrogen ion + water <=> hydrated hydrogen ion

The second main pH buffer system reversible reaction (2):

$CO_{2(aq)}$ + $H_2O_{(l)}$ <=> $H_2CO_{3(aq)}$ <=> $HCO_3^-{}_{(aq)}$ + $H^+_{(aq)}$ $pK_{(25^oC)} = 6.35$ (2)

$H^+_{(aq)}$ + $H_2O_{(aq)}$ <=> $H_3O^+_{(aq)}$ (1b)

Hydrogen ion + water <=> hydrated hydrogen ion

For a through discussion on acids and bases, refer to [45].

The proper concentration ratios of all 5 components in these 2 reactions (plus the equilibrium of the organic molecules), give the final desired blood pH between 7.35 - 7.45.

However, if the blood receives, for instance, a massive concentration of phosphoric acid and $CO_{2(aq)}$ in a matter of minutes, the 2 equilibrium reactions will frantically move in the direction to produce more products or reactants, to maintain the proper concentration balance in order to keep the pH between that narrow physiological range. The movement of these reactions, to the left or to the right will be in order to neutralize (consume) the external added component that was ingested by the person, to lower its concentration and consequently its presence in the blood.

The buffer system can handle a particular amount of concentrations of these substances and maintain the pH stable, but to a certain point. When one of the compound concentration of the buffer system (the $H^+_{(aq)}$ for instance) surpasses its ability (ratio of concentrations of all components) to regulate a great introduction of acids (or bases), the buffer capacity will end.

In the reversible reaction 1a, when phosphoric acid is ingested, there is an introduction of a compound that will impact equation 1c. Phosphoric acid is represented in equation 1c and acts indirectly in the buffer equilibrium, producing more dihydrogenphosphate ion (equation 1a). For the equilibrium (1a) to be maintained, it is "forced" to move towards the right, to the formation of more hydrogen ion and dihydrogenphosphate, to consume the excess of $H_2PO_4^-{}_{(aq)}$ produced by the ingestion of $H_3PO_{4(l)}$, to re-establish the equilibrium. This movement to the right, produces more $H^+_{(aq)}$, and therefore will acidify the medium. The more a soft drink is consumed, the more acid concentration will be released in the blood system.

The buffer system is capable of absorbing a certain amount of acid or base in order to maintain the equilibrium, and consequently, the correct pH in the blood. Although this acidity is nefarious it is absolutely crucial when concerning the dreadful effects in the case of intracellular fluid (ICF) and the kidneys, where phosphate concentrations will be higher than in the blood.

In equation 2, the other inorganic buffer in the blood, the more CO_2 is injected in the blood solution, the more the equation will produce $H^+_{(aq)}$ (equation 1b) $H^+_{(aq)} + H_2O_{(aq)} \Leftrightarrow H_3O^+_{(aq)}$) to compensate for the introduction of CO_2 in an also unexpected and sudden way. Therefore, the pH will be decreased, as H_3O^+ concentration will increase, and the need for some alkalizing substance to get rid of this excess of H_3O^+, will be of utterly urgence. The sudden ingestion of a soft drink containing 2 components that will directly bear upon the buffer system will end up having a huge impact on them.

When the buffers are no longer capable of maintaining the very narrow range of pH values in the body, death results. Considering the intelligence of our bodies, the internal system will do whatever it takes to consume the excess amount of acid and/or $CO_{2(aq)}$ ingested (in this example), and will look for the alkaline substances (e.g. minerals) in the blood to neutralize them. If none present, the system will even look for them in the bone tissues, all it takes to keep the person alive.

A colateral effect is obtained when calcium ions in the body is used, as a possibility in an urgent situation, to neutralize the excess concentration of the anion HPO_4^{2-} formed (from reaction 1a), which is the formation of $CaHPO_4$, a very insoluble product in water, in equation (4) below:

$$Ca^{2+}_{(aq)} + HPO_4^{2-}{}_{(aq)} \Rightarrow CaHPO_{4(s)} \quad (4)$$

Thus, immobilizing not only calcium ion but phosphate ions, all needed in the bone formation and maintenance.

Volemia is very important in the calculation of the buffer capacity. Considering and adult having around 5L of blood, and a child weighting 18 kg, a volemia of 1.35 L, the buffer capacity of a child is almost 5 times lesser than of an adult. The same consumption of 1 can of soda of 355 mL, can wreak havoc in the biochemistry of an infant body, a strong candidate for a diabetic, or/and obese or/and osteoporotic adult [51-53].

Depleting of minerals

Where do the calcium, for instance come from to help neutralize the excess acid suddenly in the body? The circulating extracellular calcium pool exists in three different states: a) free as a hydrated cation ($Ca(H_2O)_6^{2+}$ responsible for half of the total circulating calcium ion); b) bound to an anion and c) protein-bound - a chelation kind of bond particularly pH sensitive. (being albumin the predominant calcium-binding protein). Normally, total circulating calcium is already low in patients with protein loss due to nephrotic syndrome or impaired protein synthesis due to liver failure.

The above chemical reactions describing the buffer chemistry in the blood, kidneys and lungs, were depicted in a very simplified form, and with the physiological process not included. It is important however to say that the kidneys are more involved and subjected to damage in this back and forth of the molecules involved in the maintenance of the homeostatic pH in the whole body [23].

For further information on Physiology of buffer systems in the body, for instance, refer to [54].

Another cause of mineral depletion is hard, intense exercise with no adequate nutritional support (mainly but not only, magnesium, potassium, sodium and chloride) and chronic stress. Zn is completely depleted in the body in a "burn out" episode or in a chronic stress situation. Chronic stress, psychological stress, and sleep deprivation triggers a biochemical response that can also lead to a kind of "burning" zinc due to high demand in this stress process and also because of impaired absorption due to the same stress situation - The hypothalamic-pituitary-adrenal (HPA) axis activated in elevated cortisol levels, downregulates zinc concentrations in the blood, also called prolonged stress hypozincemia. Zn is accumulated in the hepatic cells in stress episodes and if prolonged in time, will lead to an increase in the expression of ZIP14, a zinc transporter that facilitates zinc uptake into hepatocytes, further contributing to the sequestration of zinc in the liver and systemic deficiency. This latter utilization of zinc added to the already sequestered zinc (from the blood) by the increase of the synthesis of metallothionein (MT), particular in the liver, depletes further its concentration. MT is a zinc binded protein. These two zinc stress-cortisol triggered biochemical responses, results in systemic deficiency and significantly reduces the availability of zinc in the blood for essential functions, like immune support, neurotransmission, and antioxidant defenses [40,46,55,56].

Magnesium is the fourth most abundant intracellular metal ion. This ion is essential for many biochemical processes like energy metabolism, protein and DNA synthesis, maintenance of the electrical potential and nervous and cardiac tissues, and the most important for the discussion in this work, the regulation of blood pressure. On the other hand, magnesium deficiency is one of the main causes of oxidative stress (Reactive Oxygen Species - ROS increased) due to a trigger in mitochondrial dysfunction, to an activation of the renin-angiotensin-aldosterone system (RAAS) and to abnormal regulation of calcium homeostasis [57].

In magnesium deficiency (hypomagnesemia), its exchangeable concentration in bones decreases to compensate for the diminishing concentration in the blood, thus reducing the availability for bone formation [57].

The correct absorption of the minerals and other nutrients definitely need clean and regularly detoxed emunctories in our bodies. For a through discussion on impaired or contaminated soils, plants and Detox, refer to [58] and [59].

Final Conclusion

As seen and discussed above, all essential minerals play a crucial role in the body reconstitution (which in bone case, around 10 years but can keep going till 20 years for the whole replacement (turnover) of its cells). Consequently, in all situations in which a prolonged nutrient deficiency is imposed on the body, a consequence in the form of a unhealthy situation will happen.

It has to be understood that any unhealthy situation, as well as any physical body alarm, is the soul crying out saying there is something going the wrong way: either in Nutrition, in thoughts, emotions, in behaviour or even in the person's life style [60].

Prevention is the key and Nutrition and Knowledge play a huge part in the state of health of a person. Always remember, knowledge is power!

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Conflict of Interest

The author declares that there is no conflict of interest whatsoever in the above article, and it represents the author's point of view based on the scientific published literature.

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