ALKALINE DIET AND HEALTH-A BRIEF REVIEW

Nilay N Suthar*, Anita P Verma**
*Associate Professor, Department of Medicine, Smt NHL MMC & Sheth VS Gen Hospital, Ahmedabad.
**Professor, Department of Physiology, Smt NHL MMC, Ahmedabad.

Abstract:
Plenty has been researched in modern medicine about the pH of foods, but the basic thought about the injury causing food has not been reviewed in most of the literature. Compared to our ancestors it has been investigated that the composition of the food we are taking now has changed dramatically. Increased propensity of acid-forming food has substantially increased burden on the natural buffering system of the body. More and more consumption of acid-forming food has led to a tremendous pressure on the body's defence against acidosis-acidaemia. In this review article the significance of alkaline diet is discussed in view of current scientific literature and past ancestral texts. The body will always retain your blood pH in a very tight range close to pH 7.365. Our aim should be not to change this, taking alkaline diet is to support the body's efforts to keep the pH in range.

Key Words: Alkaline, Acidosis, Acidaemia, Buffer, Pulmonary, Renal, Diet,

Author for correspondence: Dr.Nilay Suthar, Department of Medicine, Smt NHL Municipal Medical College, Ahmedabad, Gujarat,:380006, E-mail:nilaysuthar@gmail.com

Background

The words acid and alkaline (i.e. bases) are derived from direct sensory experience. The word acid comes from the Latin word *acere*, which means "sour" All acids taste sour. Well known from ancient times were vinegar, sour milk and lemon juice. The word alkaline comes from the Arabic *al-qily*, which means "to roast in a pan" or "the calcinated ashes of plants.[1] The first scientific concept of acids and bases was provided by Antoine Lavoisier in early 1776. In year 1838 Justus von Liebig proposed that an acid is a hydrogen-containing substance. Liebig's definition, while completely empirical, remained in use for almost 50 years until the adoption of the Arrhenius definition.[2] The concept of p[H] was first introduced by Danish chemist Søren Peder Lauritz Sørensen at the Carlsberg Laboratory in 1909 and revised to the modern pH in 1924 to accommodate definitions and measurements in terms of electrochemical cells.[3]

Plenty has been researched in modern medicine about the pH of foods, but the basic thought about the injury causing food is well mentioned in classical Indian texts like the Hatha Yoga Pradipika, Gheranda Samhita & Shiv Samhita. Although, these texts could not discuss about the pH of various foods, the classical explanation of types of foods mentioned well, in depth, in these texts. These texts mention that there are traditionally three kinds of foods which influence humans: *sattvic* or pure food, *rajasic* or stimulating food and *tamasic* or impure food. Examples of these foods well corroborate with their pH values.[4,5,6] Physician Charak advised in his text Charak samhita, a work about 200 AD, on right diet for health, strength and longevity. He classified the food into two main groups: heavy and light (by qualities not weight) corresponding to the *rajasic* and *tamasic* grouping. Heavy foods have the properties of earth and moon and light foods have those of air and heat. The light (or *Sattvic*) foods should predominate in a healthful diet. Even Professor E V McCollum of John Hopkins University says that the daily diet needs a considerable amount of alkaline-forming foods and moderate quantity of acid-forming foods. Examples are vegetables, fruits, grains, milk, butter and cheese. Most of these *sattvic* foods are alkaline-forming. Health depends on slightly alkaline pH for the blood stream.[7]

Inversion of the potassium-to-sodium and base-to-chloride ratios, human diet & health

It has been observed that current diet has less amount of potassium alkali salts than our ancestor's diet. This could have made humans a better diet adapted species in comparison to its ancestors. The diet has changed remarkably since the agricultural revolution a mere 10,000 years ago, and since industrialization only 200 years ago. Among the many health problems resulting from this mismatch between our genetically determined nutritional requirements and our current diet, some might be a consequence in part of the deficiency of potassium alkali salts (K-base), which are amply present in the plant foods that our ancestors ate in abundance, and the exchange of those salts for sodium chloride (NaCl), which has been incorporated copiously into the contemporary diet, which at the same time is meager in K-base-rich plant foods. There has been an decrease in potassium (K) compared to sodium (Na) and an increase in chloride compared to bicarbonate found in the diet[8]. The ratio of potassium to sodium has reversed, K/Na ratio previously was 10 to 1 whereas the modern diet has a ratio of 1 to 3. Deficiency of K-base in the diet increases the net systemic acid load imposed by the diet[9].

Human life depends on appropriate pH levels in cells and organism. Human life requires well controlled pH level in Serum of about 7.4 (Slightly alkaline 7.35-7.45)[10]. Over years, may be around 100 years, pH of ocean has dropped from 8.2 to 8.1 because of exaggerated CO_2 deposition. As known it has negatively affected coral reefs[11]. Even the pH of the soil in which plants are grown can have considerable influence on the mineral content of the food we eat (as minerals are used as buffers to maintain pH). The ideal pH of soil for the best overall availability of essential nutrients is between 6 and 7. Acidic soils below pH of 6 may have reduced calcium and magnesium, and soil above pH 7 may result in chemically unavailable iron, manganese, copper and zinc. This results in a diet that may induce metabolic acidosis which is mismatched to the genetically determined nutritional requirements[12]. With aging, there is a gradual loss of renal acid-base regulatory function and a resultant increase in diet-induced metabolic acidosis while on the modern diet[13,14].

pH of Blood and Cell interiors

pH in the body varies greatly from one part to another depending on the function of the organ. The pH of different cellular compartments, body fluids, and organs is usually tightly regulated in a process called acid-base homeostasis. The most common disorder in acid-base homeostasis is acidosis, which means an acid overload in the body, generally defined by pH falling below 7.35. Alkalosis is the opposite condition, with blood pH being excessively high.

The pH of blood is usually slightly basic with a value of pH 7.365. This value is often referred to as physiological pH in biology and medicine. Enzymes and other proteins have an optimum pH range and can become inactivated or denatured outside this range.[3]

Table: 1 pH of Various body fluids, organs, and membranes[15,16]

Organ, fluid or membrane	pH	Function of pH
Skin	Natural pH is between 4 and 6.5[17]	Barrier protection from microbes
Urine	4.6 to 8.0[18]	Limit overgrowth of microbes
Gastric	1.35 to 3.5	Break down protein
Bile	7.6 to 8.8	Neutralize stomach acid, aid in digestion
Pancreatic fluid	8.8	Neutralize stomach acid, aid in digestion
Vaginal fluid	<4.7[19]	Limit overgrowth of opportunistic microbes
Cerebrospinal fluid	7.3	Bathes the exterior of the brain
Intracellular fluid	6.0–7.2[20]	Due to acid production in cells
Serum	7.35	Tightly regulated

venous		
Serum arterial	7.4	Tightly regulated
Lysosomes	4.5	Break down waste materials and debris with pH
Granules of chromaffin cells (Adrenal)	5.5	Secrete Catecholamine & hormones with pH balance
Urine	6	Excretion of cellular by-products maintaining pH
Cytosol	7.2	Cellular liquid vital pH balance
Cerebrospinal fluid (CSF)	7.5	Buffer, basic mechanical and immunological protection to the brain
Blood	7.35-7.45	Delivers nutrients and oxygen to the cells and transports metabolic waste
Mitochondrial matrix	7.5-7.8	Part of powerhouse of Cell
Pancreas secretions	8.1	Digestive & Endocrine functions

The human body represents a precarious organization of matter. Chemical study of the body materials reveals eighty parts alkali, and twenty parts acid. This relationship of four to one is the basic secret of health, normal functional activities, and efficient old age. All our practices, habits, customs, indulgences or deficiencies, both physical and mental, either promote or disturb this eighty-twenty ratio.[17]

Acidosis, Acidaemia and Diet-Induced Acidosis

The term acidosis is often used interchangeably with the term acidaemia, with the latter referring to a blood pH of less than 7·35. Correctly used, the term acidosis refers to a process, or a trend toward acidaemia, without necessarily reaching a pH of less than 7·35, or actual acidaemia. Acidosis only becomes acidaemia when compensatory measures to correct it fail.[18] Detailed review of Acid-Base balance is beyond the scope of present paper, it can be grossly understood that basic buffers for compensation are kidneys, lungs against the acid production in the body. Naturally also acid production in the body goes on, but the acid production may become exaggerated due to more intake of acid-forming diet or food. Constant balancing acts continue in the body which balances physiologic pH of body by inducing alkalosis and acidosis. Lungs may need to breathe more to induce respiratory alkalosis and Kidneys may have to work more to induce metabolic alkalosis as part of compensation against acidosis.

The most determining factors for acid or for alkali formation are contained in food and drink. These several mineral elements are so arranged in the different foods of daily use as to separate such foods into two classes - the alkali forming foods, and the acid forming foods.[21]

Table: 2 Acid & Alkali forming Minerals[21]

Acid Forming	Alkali Forming
Phosphorus	Potassium
Sulphur	Sodium
Silicon	Calcium
Chlorine	Magnesium
Fluorine	Iron
Iodine	Manganese
Arsenic	Aluminum
Bromine	Copper
	Lithium
	Zinc
	Nickel

Diet net acid load can be estimated from measurements of urinary excretion of ammonium, titratable acids and bicarbonate (called net acid excretion; NAE), or can be calculated from dietary constituents (called Net Endogenous Acid Production; NEAP). Food contributes a net acid or base effect due to the balance between the acid-forming constituents, such as sulfuric acid produced from the catabolism of methionine and cystine in dietary proteins, and the base forming constituents, for example, bicarbonate, produced from the metabolism of the K salts of organic anions in plant foods. As predicted by the Stewart hypothesis, sodium chloride appears to affect systemic acid–base status independently of the net acid load of the diet, perhaps by affecting renal excretion of Cl^{-}/NH_4^{+} or by a strong ion effect[9]. The effects of sodium chloride are especially relevant, given the high salt content of the typical diet in industrialized countries.[22]

Studies in Hunter–Gatherer Tribes suggested high intake of plant foods compared with modern-day humans[19]. In a study, they estimated the net acid load (NEAP) of 159 hypothetical pre-agricultural diets, 87% were found to be base producing, with an estimated mean NEAP of negative 88 mEq/d. In comparison, calculations from the US Third National Health and Nutrition Examination Survey (NHANES III) found that the average American diet is acid-producing, with an NEAP of positive 48 mEq/d[20]. This represents that we switched from the net base-producing diet to the net acid-producing diet for only several thousand years. So there is common consensus from several studies that there is a potential a chronic low-grade metabolic acidosis especially among those eating the typical Western diet. Several researches emphasis the effects of reducing or eliminating this diet acid load by altering the diet or giving base supplements.

Human body maintain a tightly controlled pH of around 7·40 in the extracellular fluid by respiratory excretion of carbon dioxide and renal excretion of non-carbonic (non-volatile) acid or base[22,21]. Everyday metabolism produces acid as non-volatile sulfate from protein-amino acid catabolism. Non-metabolized organic acids and phosphoric and other acids also increase acid load in body. The kidney reabsorbs all of the filtered bicarbonate (HCO_3^{-}) and it generates new bicarbonate in the collecting duct. Under normal steady-state conditions, the net quantity of acid secreted and the consequent renal generation of new bicarbonate equals the rate of metabolic proton-hydrogen ion generation, preserving pH balance. In case of metabolic acidosis, either non-volatile acid accumulates, or HCO_3^{-} is lost and this can be happening even when the plasma HCO_3^{-} is within the range considered to be normal (24–28mmol/l)[22,22].

Acute acid load can temporarily imbalance the pH balance mechanism but chronic acid load imbalance the system and overload the buffering system when chronically diet releases non-carbonic acid in systemic circulation. The quantum of imbalance in acid & base production determines the NEAP of the diet. Equilibrium can be maintained by grossly three compensations: buffering, increased breathing-ventilation and augmented renal reabsorption and generation of bicarbonate (HCO_3^{-}). Bone act as a major reservoir of buffer in the form of alkaline salts of Calcium. So, extracellular H^{+} is a key inducer of osteoclastic activity. pH reduction of even $\leq$0.1 is sufficient to double resorption of minerals from bone. Frick et al demonstrated that ovarian cancer G protein-coupled receptor-1 (OGR1) is the proton-sensing receptor on the osteoblast that leads to osteoclast activation[22,23,24,25,26]. The internal environment changes the pH of urine depending on the systemic need. Renal acid load can be estimated from urinary acid excretion. There are several formulas for measuring Potential Renal Acid Load (PRAL).

Acid excretion in the urine can be estimated by a formula described by Remer (sulfate + chloride + 1.8x phosphate + organic acids) minus (sodium + potassium + 2x calcium + 2x magnesium) mEq[27]. Foods can be categorized by the potential renal acid loads (PRALs).

Table: 3 Potential renal acid loads (PRALs) of selected foods[15,31]

Food or food group	PRAL mEq of: Cl + PO_4 + SO_4 – Na – K – Ca – Mg
Dairy	
Parmesan cheese	34.2
Processed cheese	28.7
Cheddar reduced	26.4
Hard cheese	19.2
Fresh cheese	11.3
Cottage cheese	8.7
Yogurt whole milk	1.5
Ice Cream	0.8
Whole milk	0.7
Buttermilk	0.5
Eggs	
Eggs yolk	23.4
Eggs white	1.1
Eggs chicken whole	8.2
Meats	
Corned beef	13.2
Luncheon meat	10.2
Turkey	9.9
Veal	9
Lean beef	7.8
Frankfurters	6.7
Sugars	
Sugar white	−0.1
Honey	−0.3
Vegetables	
Cucumber	−0.8
Broccoli	−1.2
Tomato	−3.1
Eggplant	−3.4
Celery	−5.2
Spinach	−14.0
Fats and Oils	
Butter	0.6
Margarine	−0.5
Olive oil	0
Fruits and nuts	
Peanuts	8.3
Walnuts	6.8
Grape juice	−1.0
Orange juice	−2.9
Apples or apple	−2.2
Apricots	−4.8
Banana	−5.5
Black currents	−6.5
Raisins	−21.0
Grains and grain	
Brown Rice	12.5
Rolled Oats	10.7
Spaghetti whole	7.3
Spaghetti white	6.5
Cornflakes	6
Rice white	4.6
Bread rye flower	4.1
Bread whole wheat	1.8
Legumes	
Lentils green and	3.5
Green beans	−3.1
Fish	
Trout brown	10.8
Cod fillets	7.1
Beverages	
Beer pale	0.9
Coca-Cola	0.4
Beer draft	−0.2
Wine white	−1.2
Coffee infusion	−1.4
Wine red	−2.4

NEAP is dependent on PRAL of the food or diet one is taking. It can be calculated as per the formula researched. Table: 5 describe several algorithms to determine net endogenous acid production (NEAP).

Detail discussion about NEAP and PRAL is beyond the scope of article. Following are the signs & symptoms which help one identify tendency of being acidic or alkali systemic state.

Allow yourself a mark of ten for each positive answer under both columns. Total the figures and you will have a fairly accurate gauge to your acid tendencies.

Table: 4 Acid & Alkali effect[17]

Acid Effects	Alkali Effects
Having local infection,	No known local infection
Infection at teeth, tonsil, nose or elsewhere	Non-smoker
Smoker	Non-user of alcohol
Using alcohol	Low protein diet (2½ oz. daily)
Heavy protein diet (over 2½ oz. daily)	Sparing use of starchy food
Heavy starch consumption	No fried foods
Foods cooked in fats or fried	One fruit meal daily
Sparing use of fresh fruits	Abundant use of green vegetables
Only scant use of green vegetables	Drink several glasses water daily
Drink little water	Two or three bowel movement daily
Constipated	Never use
Using Aspirin and other drugs	Aspirin or similar drugs
Given to worry and anger	Hardly ever worried or become angry
Little outdoor exercise	Regular outdoor exercise
Frequent late nights	Retire early and secure full night sleep

Discussion:

So, from several studies and some past literature it can be concluded that, Lungs & Kidneys act as a pivotal system for maintaining acid-base balance in the body. Thirty quarts of carbonic acid gas is normally eliminated by the lungs every hour. It is largely the result of digesting the sugar, starch, fat and protein of the daily food intake. Sedentary habits with 'good feeding' may easily overburden lung elimination, with resultant chronic acidosis effects. Vaguely 1/3rd of the total body acid wastes are disposed of through the lungs, this leaves 2/3rd to be eliminated by kidneys, skin and bowels. An amount of blood equal to all the blood in the body (six quarts) passes through the two kidneys roughly every seven minutes for the purpose of eliminating acid waste products of a nature that cannot be eliminated in the form of gas through the lungs. Urinary pH is a relatively very good index of body acidity or acid load. Normally the urine is slightly acidic. Persons who are producing an excess of acid may have a urine reaction showing many times as acid as the blood. Such excessive strain on the eliminative function of the kidneys will result in disease of these organs.[17] Clinically-recognized chronic metabolic acidosis has deleterious effects on the body, including growth retardation in children, decreased muscle and bone mass in adults, and kidney stone formation, and that correction of acidosis can ameliorate those conditions.[9]

Table: 5 Algorithms to determine net endogenous acid production (NEAP)[22]

Algorithm	Formula for 'estimated NEAP' (mEq/d)
Remer & Manz	PRAL (mEq/d) + OA_{est} (mEq/d) PRAL = 0·4888 × protein (g/d) + 0·0366 × P (mg/d) − 0·0205 × K (mg/d) − 0·0263 × Mg (mg/d) − 0·0125 × Ca (mg/d) OA_{est} (mEq/d) = body surface area × 41/1·73 Body surface area (m^2) = 0·007184 − height $(cm)^{0·725}$ − weight $(kg)^{0·425}$
Sebastian *et al.*	Sulfuric acid (mEq/d) + organic acids (mEq/d) − bicarbonate (mEq/d) Sulfuric acid based on cystine and methionine content of protein (US Department of Agriculture database), assuming fractional intestinal absorption rate of 75 %, and complete metabolism to sulfuric acid Organic acids = 32·9 + 0·15 × diet unmeasured anion content (which equals $Na^+ + K^+ + Ca^{2+} + Mg^{2+} - Cl^- - P_i$ Bicarbonate = 0·95 × (Na^+) + 0·80 × (K^+) + 0·25 × (Ca^{2+}) + 0·32 × (Mg^{2+}) − 0·95 × (Cl^-) − 0·63 × (P_i) (all in mEq/d)
Frassetto *et al.*	(0·91 × protein (g/d)) − (0·57 × K (mEq/d)) + 21 or (54·5 × protein (g/d)/K (mEq/d)) − 10·2
Renal net acid excretion analysed	TA + NH_4 − HCO_3 (24 h urine, all in mEq/d)

PRAL, potential renal acid load; OA_{est}, organic acids estimated; P_i, inorganic P; TA, titratable.

The acidic food, does not directly damages our internal system. There is a definite buffer system which protects the organism from academia. Putting lots and lots of acid-forming foods puts the body into a huge tailspin and the damage snowballs. The constant consumption of over-acidic foods and an over-acidic lifestyle leads to massive long term problems. The body will make all manner of long-term sacrifices to your health in order to maintain your short term health by keeping the pH of those cellular fluids at 7.365. The alkaline diet is not aiming to change this 7.365, it's aiming to support the body, remove the stress of an acidic lifestyle and give the body the tools it needs to thrive.[28].

So we can sum up here that, the body will always retain your blood pH in a very tight range close to pH 7.365. Our aim should be not to change this, taking alkaline diet is to support the body's efforts to keep the pH in range. The standard, modern, western diet is incredibly acidic, and ingesting such an acidic diet puts incredible pressure on the body to try and neutralize these acids to maintain the pH slightly alkaline i.e.: 7.365. By adding alkaline diet one can prevent overwhelming systemic buffer system. So the caveat of taking alkaline diet states that the real damage is done to the body not in consuming acid-forming foods, but it is the fallout of the body having to work very hard to neutralize these acids and retain the pH at 7.365.[28] Avoid hastening the point of acid-saturation by providing nature with an abundance of acid-binding foods[17]. There definitely a greater need to generate statistical significant evidence based data to support the hypothesis of using more alkaline food and less acid-forming food to make it applicable as a uniform dietary guideline.

The science is clear: it's the overall pattern of living that's important. You can lower your risk if you move more, stay lean and eat plenty of vegetables and fruit, as well as other plant foods such as whole grains and beans.[29]

"There is no natural death; all deaths from so-called natural causes are merely the end and point of a progressive acid saturation." Dr. George W. Crile

ACKNOWLEDGEMENT:

Authors acknowledge respected Verdhi Thakkar for enriching their knowledge. Authors also acknowledge the immense help received from the scholars whose articles are cited and included in references of this manuscript. The authors are also grateful to authors / editors / publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed. We thanks for the constant support of our patients, friends and institute head for the help provided at all levels.

Conflict of Interest: None to be declared

References:

[1] Early Acid Base History. (n.d.). Retrieved December 13, 2014, from http://dwb4.unl.edu/Chem/CHEM869R/CHEM869RLinks/www.nidlink.com/7Ejfromm/lavoisier.htm

[2] Acid–base reaction. (2014, December 11). In Wikipedia, the free encyclopedia. Retrieved from http://en.wikipedia.org/w/index.php?title=Acid%E2%80%93base_reaction&oldid=636204693

[3] pH. (2014, December 12). In Wikipedia, the free encyclopedia. Retrieved from http://en.wikipedia.org/w/index.php?title=PH&oldid=637803282

[4] HathaYogaPradipika-SanskritTextWithEnglishTranslatlionAndNotes.pdf. (n.d.). Retrieved December 13, 2014, from https://ia700401.us.archive.org/35/items/HathaYogaPradipika-SanskritTextWithEnglishTranslatlionAndNotes/HathaYogaPradipika-SanskritTextWithEnglishTranslatlionAndNotes.pdf

[5] Vasu, Shri Chandra, (tr), Gheranda Samhita, Adyar, Madras, 1933

[6] Vidyrnava, Rai Bahadur Srisa Chnadra, (tr) Siva Smahita, Sudhindfra Nath Basu, The Panini Office, Alllahabad, 1923.

[7] Hewitt J. The Complete Yoga Book: Yoga of Breathing, Yoga of Posture, Yoga of Meditation
A Rider book. 1991:550.

[8] A. Sebastian, L. A. Frassetto, D. E. Sellmeyer, R. L. Merriam, and R. C.Morris Jr., "Estimation of the net acid load of the diet of ancestral preagricultural Homo sapiens and their hominid ancestors," American Journal of Clinical Nutrition, vol. 76, no. 6, pp. 1308–1316, 2002.

[9] Frassetto L, Morris RC, Jr., Sellmeyer DE, Todd K, Sebastian A. Diet, evolution and aging--the pathophysiologic effects of the post-agricultural inversion of the potassium-to-sodium and base-to-chloride ratios in the human diet. European journal of nutrition 2001;40:200-13.

[10] A.Waugh and A. Grant, Anatomy and Physiology in Healthand Illness, Churchill Livingstone Elsevier, Philadelphia, Pa, USA, 10th edition, 2007.

[11] O. Hoegh-Guldberg, P. J. Mumby, A. J. Hooten et al., "Coral reefs under rapid climate change and ocean acidification," Science, vol. 318, no. 5857, pp. 1737–1742, 2007

[12] M. Konner and S. Boyd Eaton, "Paleolithic nutrition: twenty five years later," Nutrition in Clinical Practice, vol. 25, no. 6, pp. 594–602, 2010.

[13] R. D. Lindeman and R. Goldman, "Anatomic and physiologic age changes in the kidney," Experimental Gerontology, vol. 21, no. 4-5, pp. 379–406, 1986.

[14] J. Dam-ampai SO and C. Nilnond, "Effect of cattle manure and dolomite on soil properties and plant growth in acid upland soils," Songklanakarin Journal of Science and Technologh, vol. 27, supplement 3, pp. 727–737, 2005.

[15] Schwalfenberg, G. K. (2011). The alkaline diet: is there evidence that an alkaline pH diet benefits health?. Journal of Environmental and Public Health, 2012.

[16] Boron, Walter, F.; Boulpaep, E.L. (2004). Medical Physiology: A Cellular And Molecular Approaoch. Elsevier/Saunders. ISBN 1-4160-2328-3.

[17] Are you Acid? - Diet and Diet Reform. (n.d.). Retrieved December 13, 2014, from http://www.mkgandhi.org/health/diet_reform/48acid.html

[18] Pizzorno, J., Frassetto, L. A., & Katzinger, J. (2010). Diet-induced acidosis: is it real and clinically relevant?. British journal of nutrition, 103(08), 1185-1194.

[19] Cordain L, Miller JB, Eaton SB, et al. (2000) Plant–animal subsistence ratios and macronutrient energy estimations in worldwide hunter-gatherer diets. Am J Clin Nutr 71, 682–692.

[20] Sebastian A, Frassetto LA, Sellmeyer DE, et al. (2002) Estimation of the net acid load of the diet of ancestral preagricultural Homo sapiens and their hominid ancestors. Am J Clin Nutr 76, 1308–1316.

[21] Paulev PE & Zubieta-Calleja GR (2005) Essentials in the diagnosis of acid–base disorders and their high altitude application. J Physiol Pharmacol 56, Suppl. 4, 155–170

[22] Gluck SL (1998) Acid–base. Lancet 352, 474–479.

[23] Brandao-Burch A, Utting JC, Orriss IR, et al. (2005) Acidosis inhibits bone formation by osteoblasts in vitro by preventing mineralization. Calcif Tissue Int 77, 167–174.

[24] Bushinsky DA (1996) Metabolic alkalosis decreases bone calcium efflux by suppressing osteoclasts and

stimulating osteoblasts. Am J Physiol 271, F216–F222.

[25] Bushinsky DA (1996) Stimulated osteoclastic and suppressed osteoblastic activity in metabolic but not respiratory acidosis. Am J Physiol 268, C80–C88.

[26] Frick KK, Krieger NS, Nehrke K, et al. (2009) Metabolic acidosis increases intracellular calcium in bone cells through activation of the proton receptor OGR1. J Bone Miner Res 24, 305–313.

[27] T. Remer and F. Manz, "Estimation of the renal net acid excretion by adults consuming diets containing variable amounts of protein," American Journal of Clinical Nutrition, vol. 59, no. 6, pp. 1356–1361, 1994.

[28] Alkaline Diet Myth #1: You Can't Change Your pH! (n.d.). Retrieved December 14, 2014, from http://www.energiseforlife.com/wordpress/2013/01/21/alkaline-diet-myth-1-you-cant-change-your-ph/

[29] Nutrition and fitness. (n.d.). Retrieved December 14, 2014, from http://www.cancer.ca/en/prevention-and-screening/live-well/nutrition-and-fitness/?region=bc