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PH of Food Products and the Suitable Diet for Individuals with Blood PH Imbalances

Hebah Abdel-Wahab[1,*], Tamara Gund[2], Joseph Bozzelli[2]

[1]Department of Chemistry and Biochemistry, Saint Joseph University, Philadelphia, PA 19131
[2]Department of Chemistry, New Jersey Institute of Technology, Newark NJ, US
*Corresponding author: Dr.heathera@gmail.com

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Abstract PH is a scale to determine if a solution is acidic, basic or neutral. Food can be acidic or basic based on the nutrients it forms after the food is metabolized. Blood PH can be measured using Artery Blood Gas Test, the ABG test. Normally blood PH is between 7.35-7.45. Blood is a buffer solution, where it resists change in its PH. Excessive consumption of acidic or basic food products or having a medical condition can cause the blood PH to become too acidic or too alkaline, breaking the blood buffer capacity. Small changes in blood PH represent big gaps in the acidity or the alkalinity. The objective is to classify food products as acidic, basic or neutral based on their PH after its metabolized, to determine the suitable diet for individuals with blood PH imbalances in order to minimize and improve the symptoms, and to determine the recommended amount of each food type; carbohydrate, fat, and protein in the 2000 daily calorie intake. Acidic and basic food products are listed tables 1-5. A basic diet is used if the blood PH is acidic and an acidic diet is used if the blood PH is basic. The recommended amount of fat, proteins and carbohydrates are 20-35%, 10-30% and 45-65%.

Keywords: *PH, Food Products, Blood PH, Food PH, Blood PH Imbalances, Suitable Diets, Diets*

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1. Introduction

PH is a scale ranging from 0-14, and it's used to determine if a medium is acidic, basic or neutral. The PH of a solution is measured in the laboratory using p-hydroin paper and more accurately using a PH meter. A PH of 7 indicates a neutral solution, of less than 7 indicates an acidic solution, and of greater than 7 indicates a basic solution. Acids are substances with a PH of less than 7. Example for acids is acetic acid (vinegar), citric acid (vitamin C), sulfuric acid (battery acid), and hydrochloric acid (digestive fluid in the stomach). Bases are substances with PH greater than 7. Example for bases is sodium hydroxide as in drain cleaners, magnesium hydroxide used in antacid and in laxatives, and ammonia used in household cleaners. In the laboratory an acidic solution can be made neutral by adding certain calculated amounts of a base, and a basic solution can be made neutral by adding certain amount of acid in a neutralization reaction (an acid-base reaction). A buffer solution resists the change of PH if acid or base are added to the solution as it contains a week conjugate acid/ base pair. A solution containing HF and NaF is an example of a buffer solution. Blood is another example of a buffer solution of a PH of 7.4 as it contains carbonate HCO_3^- and carbonic acid H_2CO_3. Acidolysis or alkalosis can occur if your blood PH is outside this range, and it can be dangerous and fatal. A lower blood PH value of 6.8 or higher value from 7.8 would lead to death. [1,2]

The PH vary from one area to another in the body. The highest acidity area in the body is the stomach, with a PH= 1.35-3.5, as it protects against microbial organisms, and aids in the digestion. In the stomach, the layer outside the epithelium is basic to prevent mucosal injury. The skin is acidic, with a PH=4-6.5 as it acts as a protective barrier against the environment microbial overgrowth. There is a gradient in the skin layers as the outer layer has a PH of 4 and basal layer has a PH of 6.9. The PH of the vagina is less than 4.7 which protects from microbial overgrowth. [3,4,5]

Acid-base vulnerability can be caused by the excessive consumption of acidic foods compared to basic foods or vice versa or an existence an underlying medical condition. Metabolic acidolysis is the result of the excessive consumption of acidic foods, and it can result in the following diseases: chronic kidney disease, kidney stones, type 2 diabetes, mortality, lean body mass loss, hypertension and osteoporosis. [6,7,8,9,10,11,12,13]

Some medical conditions can reduce blood PH and other medical conditions can increase blood PH. Metabolic or raspatory acidolysis can reduce blood PH and metabolic or raspatory alkalosis can increase blood PH. Normal artery blood PH is between 7.35 and 7.45. Small changes in blood PH represent big gaps in the acidity. Carbonic acid is produced in the body, and it's

produced from the reaction of carbon dioxide with water. Carbon dioxide is produced in the tissues due to the respiration process. The two main organs that regulate blood PH are the kidney and the lungs. Lungs rapidly regulate blood PH through exhaling carbon dioxide preventing the blood from being too acidic. Kidneys regulate blood PH slowly (days or hours) by regulating and producing bicarbonates and excreting acids in urine increasing blood PH. Some medical conditions cause the change in blood PH. A PH of below 7.35 causes acidolysis where the blood to be too acidic, and a PH of above 7.45 causes alkalosis where the blood PH is too basic. Increased acid level or reduced carbonates causes metabolic acidolysis. Raspatory acidolysis is caused if less carbon dioxide is removed from the body. Reduced acid levels or increased bicarbonates cause metabolic alkalosis. Raspatory alkalosis is caused if the body removes more carbon dioxide than usual. Blood PH can be measured by electrolyte testing or arterial blood gas testing. It's important to identify and treat the underlying conditions to restore normal blood PH levels. [14,15,16,17,18,19]

Health problems can arouse from the blood becoming too alkaline or too acidic. High levels of acid in the body are known as acidolysis. Acidolysis can be caused from certain health conditions, dietary factors or prescription drugs. Severe acidolysis can be fatal if not treated. Acidolysis can be either raspatory, metabolic, and it's either diet induced or drug induced. Disruption of metabolism can cause metabolic acidolysis due to some possible health conditions: insulin resistance, diabetes, severe diarrhea, Sjogren's syndrome, or biliary fistula. Metabolic acidolysis can be caused due to these per-existing medical conditions and can also cause these medical conditions to arouse. Raspatory acidolysis can be caused by excess carbon dioxide buildup in the body and low oxygen levels and increasing the acid level. Stroke, opioids, chronic obstructive pulmonary disease, and disorders that affect muscles involved in breathing cause raspatory acidolysis. Acidolysis can cause osteoporosis and muscle loss, as the excess acid takes calcium from the bones to neutralize the excess acid. Metabolic acidolysis can cause improper growth in children, increased kidney damage, high blood sugar, diabetes, and osteoporosis. Sodium carbonate or sodium citrate pills are used in the treatment of metabolic acidolysis, making breathing better is the approach in the treatment of raspatory acidolysis, and using a plant-based protein instead of animal-based protein is the approach in the treatment of diet induced acidolysis. Alkalosis occurs when the body contains too many bases, and it can either metabolic alkalosis (too much bicarbonate in the blood due to liver disease) or raspatory alkalosis (caused by low carbon dioxide level in the blood). Alkalosis can be caused by liver or lung disease or due to the consumption of certain medications. Proper PH balance of bases and acids in the blood are maintained by the lung and the kidney. Increased bicarbonate or decreased carbon dioxide in the body makes the body too alkaline, causing alkalosis. Metabolic alkalosis can be caused by either dehydration, cystic fibrosis, hypochloremia, electrolyte imbalances, hyperaldosteronism, recurrent vomiting or kidney disease. Respiratory alkalosis can be caused by sepsis, lung disease, anxiety, panic, fever, lack of oxygen or liver disease. Both sepsis, anxiety or panic can cause hyperventilation. Conditions such as pulmonary embolism, pneumonia or asthma can cause hyperventilation and alkalosis. Lack of chloride such as from prolonged vomiting can cause hypochloremic alkalosis. Kidney's response to lack of potassium caused from taking water pills can also cause hypokalemic alkalosis. Food can affect the balance between alkaline and acid in the body causing diet-induced acidolysis if increased blood acidity occurs. A diet can be acidic due to increasing levels of phosphoric acid, salt, or amino acids containing sulfur (eggs, meats, and dairy products). Prescription medications such as statins, antiretrovirals, beta blockers, and antibacterial drugs can cause drug-induces acidolysis. [20,21,22,23,24,25]

The body contains large reservoir of base in the form of calcium phosphates and carbonates. Modern diet containing acid load leads to the release of these salts to bring about the PH homeostasis. Over time this acid load modern diet leads to loss of calcium in an amount as high as 480 mg in 20 years in the urine or almost half the skeletal mass of calcium. Osteoporosis is not directly caused by only the urinary loss of calcium. In healthy old adults, increasing the base content of a diet in the form of bicarbonate leads to Osteoporosis. Lack of intestinal absorption of minerals is thought to result in Osteoporosis, and adequate vitamin D level of > 80 nmol/L may allow the absorption of the minerals, magnesium, calcium and phosphate. [26,27,28,29,30]

Hyperchloremic Metabolic acidolysis can be caused by the excess sodium in the diet when consuming acidic diet. Excess sodium in diet results in osteoporosis and hypertension by increasing protein wasting and bone resorption. Bone density decreases with high acid protein diet when it isn't buffered by alkali rich foods. [31,32,33,34,35]

Potassium rich diet as vegetables and fruits and reduced acid load diets resulted in the preservation of muscle mass in older women and men. Less acidolysis in the blood is shown after providing acute acidolysis for younger patients with sodium bicarbonate prior to exhaust exercise. [36,37]

Mortality and morbidity can be reduced by using an alkaline diet in case of metabolic acidolysis. Alkaline diet mostly includes alkaline fruits and alkaline vegetables. Some fruits and vegetables are acidic and should minimize their consumption in this case. An increased dietary load caused small changes in PH balance, reducing the PH by increasing $[H^+]$ and reduction in $[HCOO_3^-]$), as indicated by Kurtz 1983. A small change in PH imbalance has a large effect on metabolism. Diet induced acidolysis in case of metabolic acidolysis is associated with hypertension, impairment of bone metabolism, and some non-commutable diseases. Acid foods should be avoided. [38,39,40]

Food and drink choices you make directly affect the body's PH. The body is energized as a result of alkaline forming reactions. On the other hand, acid forming reactions in the body results in decreased ability to energize the body. The slight alkalinity of the body results in efficiently using oxygen to produce oxygen free radicals. Acidification can cause demineralization sacrificing bones and teeth, protein structures and enzyme required to maintain good health, and may cause

osteoporosis. Research by European scientists Bernard, Bechamp, and Enderlein, show experimentally that disruption of the internal biological environment results in diseases. The internal condition of the body allows microorganisms of either bad or good to spread rapidly. If the internal conditions were correct and balanced; proper PH balance, adequate minerals and healthy immune, pathogenic organism had minor or no effect on the person. And if the conditions were imbalanced, lacking nutrients and minerals would lead to sickness and diseases. Prescription drugs treat the symptoms, and it doesn't address the underlying causes, the body is unable to maintain the proper balance of health and a proper PH of 7.4. The body handles different types of food differently, for example, vegetables, and some fruits are mostly alkalizing, whereas meats, grains, sugars, nuts, seeds and beans are mostly acid forming foods. Acid forming foods should balance alkaline forming foods. Acid forming foods would digest slowly, require energy and has a heating effect on the body. Alkaline forming foods produce energy and have a cooling effect on the body. The body produces acid forming reactions in hot temperatures and produces alkaline forming reactions in cooler temperatures. The proper PH for humans is a blood PH of 7.4, and a PH of 6.5 for urine and saliva. A PH above or below the proper PH causes imbalance microorganisms' growth. [41,42,43,44] [45,46,47,48]

The acidity or alkalinity of byproducts formed after the food is digested determines whether the food is acidic or alkaline. Typically, the kidney keeps the blood PH constant by excreting the excess acid or base byproducts formed through the urine. Meats and grains contain acidic nutrients, such as sulfur, protein and phosphorus, and most vegetables and fruits contain highly basic nutrients such as calcium, potassium and magnesium. Lemon juice produces alkaline byproducts once ingested making it an alkaline not an acidic vegetable. [49,50]

Changes in diet can be made if your blood (body's) PH is acidic or basic to improve the symptoms. Acidic foods have a PH of less than 7, and basic foods have a PH of greater than 7 after the food is metabolized. If you have problems with acidity, you should avoid acidic foods and incorporate basic foods into your diet and vice versa. Acidic food is sugars, grains, cheese, processed foods, fish, meats and sodas. Basic foods are leafy green vegetables, some oils, tomatoes, broccoli, cucumber, grapefruit, and avocado. [51]

According to the United States Department of Agriculture, the recommended amount of fat, proteins and carbohydrates are 20-35%, 10-30% and 45-65%. [52,53] According to the CDC, the national center for health statistics, the mean intake of nutrients; fat, protein and carbohydrates are 36%, 16%, and 46-47% for adults, and these figures vary slightly by age and gender. For adults 20 years and older, the mean dietary intake of carbohydrates, protein and fat are: 47.4%, 15.7%, and 36.1% kilocalorie intake for women, and 45.9%, 16%, and 35.6% kilocalorie intake for men of the daily 2000 calorie intake. [54]

2. Experimental

Food can be classified into acidic, basic (alkaline) or neutral depending on the acidic or basic byproducts formed once they are digested. Food can also be sub-classified according to the type of nutrient into three main nutrient's types; carbohydrates, fats and proteins. [55,56]

Grains and meats tend to contain acidic nutrients; sulfur, phosphorus, and proteins increasing amount of acid in the body. Some fruits and most vegetables tend to contain alkaline nutrients; calcium, potassium and magnesium decreasing the amount of acid in the body. Lemon juice and grapefruit produce alkaline byproducts once its metabolized. Blood pH must maintain a range of 7.35-7.45 for the cells to function properly. Neutral foods are starch and some neutral fats. Acidifying foods are fish, dairy products, alcohols, eggs, poultry, grains, carbohydrates, processed foods, sugars, soda, sweetened beverages, and meats. Alkalizing foods are some fruits, most vegetables, and some nuts. [57,58]

Carbohydrates are found in fruits, vegetables, seeds, grain, dairy products and nuts. They are sugars in foods or undigestible fiber. Carbohydrates can be complex carbohydrates made of sugar units; starch, occurring naturally in grains, beans, peas, and vegetables or fiber also a complex carbohydrate found in cooked dry beans and peas, whole grain, fruits and vegetables or sugars called simple carbohydrate made of one or two types of sugars; lactose in dairy products and sucrose in honey or table sugar. [55,59,60,61,62,63]

Proteins are the building blocks for bones, muscles, skin and all tissues in the body. It's essential for cell growth, development and repair, and it supports bodily functions including enzymes and hormones formation, energy source, and immune system function. Protein also helps transport oxygen in the body using hemoglobin. Proteins can be found in fish, poultry, peas, lentils, beans and meats in general. All cells in the body are made up of proteins. Proteins can also function in membranes as transport in enzymes, serum albumin, hair, nail, and as hormones. All proteins are made of different amino acids. [64,65,66,67]

Fat helps in the absorption of fat-soluble vitamins, provides energy, maintains healthy hair, skin and nail, organ protection, and helps hormone production. Fat can be found in oils, margarine, butter, lard, cheese, nuts and seeds. [68]

Table 1-5 lists vegetables, fruits, nuts and seeds, carbohydrates and bread types, and oils based on their acidity and alkalinity. 69-77. Almost all vegetables are found to be basic (alkaline), except a few are found to be acidic. Fruits, seeds and nuts, bread and carbohydrates are mostly acidic except a few are found to be alkaline. Some oils and seeds are alkaline, and some are acidic. Other food products not listed on tables 1-5; dry beans and lentils are alkaline, meats; bacon, beef, poultry, fish, tuna, eggs, corned beef are acidic, dairy products; cheese, yoghurt, sour cream, butter, ice cream and cottage cheese are acidic, and non-dairy milk; goat milk and almond milk are alkaline. Most drinks are acidic: alcohol, water, carbonated water, coffee, cocoa, energy drinks, sport drinks, decaffeinated drinks, and green tea. Very few drinks are alkaline: alkaline water, and herbal tea. Sweeteners, drugs, alcohols, cigarettes, candies, honey, chocolates, sauces, artificial sweeteners, corn syrup, fructose, processed sugar, saccharine, sucrose, sucralose,

maple syrup, mayonnaise, ketchup, mustard, pickles, and vinegar are acidic. Herbs and spices are mildly alkaline.

Table 1. Acidic and Basic Vegetables* [69-77]

Vegetable Type	PH
Asparagus	Mildly Alkaline
Broccoli	Highly Alkaline
Zucchini	Alkaline
Green Beans	Moderately Alkaline
Spinach	Highly Alkaline
Kale	Highly Alkaline
Sprouts	Highly Alkaline
Cabbage	Moderately Alkaline
Sweet Potato	Alkaline
Coriander	Alkaline
Cauliflower	Mildly Alkaline
Carrot	Mildly Alkaline
Eggplant	Alkaline
Garlic	Moderately Alkaline
Onion	Moderately Alkaline
Parsley	Highly Alkaline
Celery	Moderately Alkaline
Cucumber	Highly Alkaline
Peas	Mildly Alkaline
Lettuce	Moderately Alkaline
Radish	Alkaline
Tomatoes	Moderately Alkaline
Lemon	Moderately Alkaline
Lime	Moderately Alkaline
Mushrooms	Highly Acidic
Corn	Acidic
Olives	Acidic

* PH is based on the effect of the food type on the body after its consumed.
Eggplants and Zucchini tuns acidic after cooking. [74]

Table 2. Acidic and Basic Fruits*[69-77]

Fruit Type	PH
Plum	High Acid Food
Honeydew Melon	Acidic
Orange	Acidic
Pineapple	Acidic
Apple	High Acid Food
Apricot	Acidic
Grapes	Acidic
Dates	Acidic
Mango	Acidic
Peach	High Acid Food
Pear	Acidic
Prunes	Acidic
Raisins	Acidic
Raspberries	High Acid Food
Strawberries	High Acid Food
Tropical Fruits	Acidic
Berries	High Acid Food
Cantaloupe	Acidic
Cranberries	High Acid Food

Grapefruit	Mildly Alkaline
Fresh Coconut	Mildly Alkaline
Avocado	Moderately Alkaline

* PH is based on the effect of the food type on the body after its consumed.

Table 3. Acidic and Basic Nuts and Seeds*[69-77]

Nuts or Seeds Type	PH
Cashews	Acidic
Peanuts	Acidic
Pecans	Acidic
Pistachios	Acidic
Walnuts	Acidic
Brazil Nuts	Acidic
Chestnuts	Acidic
Hazelnuts	Acidic
Macadamia Nuts	Acidic
Almonds	Alkaline
Coconut	Mildly Alkaline
Flax Seeds	Alkaline
Pumpkin Seeds	Alkaline
Sesame Seeds	Alkaline
Sunflower Seeds	Alkaline

* PH is based on the effect of the food type on the body after its consumed.

Table 4. Acidic and Basic Carbohydrates and Breads *[69-77]

Carbohydrates and Breads Type	PH
Sprouted Bread & Wraps	Alkaline
Gluten/Yeast Free Breads & Wraps	Alkaline
Brown Rice	Alkaline
White Breads	Acidic
Chips	Acidic
Pizza	Acidic
Biscuits	Acidic
Pastas	Acidic
Rice & Noodles	Acidic
Potatoes	Acidic
Sweet Potatoes	Alkaline

* PH is based on the effect of the food type on the body after its consumed.

Table 5. Acidic and Basic Oils *[69-77]

Oils	PH
Olive Oil	Alkaline
Avocado Oil	Mildly Alkaline
Coconut Oil	Mildly Alkaline
Flax Oil	Mildly Alkaline
Cooked Oil	Acidic
Solid Oil (Margarine)	Acidic
Oil Exposed to Heat, Light or Air	Acidic
Sunflower Oil	Mildly Acidic
Grapeseed Oil	Mildly Acidic
Butter	Moderately Acidic

* PH is based on the effect of the food type on the body after its consumed.

Table 6 lists PH of dairy and nondairy milk, and all milk products are found to be acidic. Milk can be either dairy or non-dairy. All dairy and most nondairy milk have an acidic PH, ranging from 4.19-7. Dairy milk is classified into four main categories: whole milk, reduced fat milk, low fat and fat free milk. Dairy milk has a PH ranging from 6.4-6.9, with a slightly increasing PH for the fat free milk, making the fat free milk slightly more basic than whole milk. Nondairy milk: nut milk**,** cashew milk, hazelnut milk, macadamia nut milk, walnut milk, peanut milk, pistachio milk, coconut milk, plant milk, oat milk, hemp milk, sesame milk, banana milk, flaxseed milk**,** soy milk**,** rice milk**,** and pea milk. Different manufacturing processing of the nondairy milk results in slightly different PH of the milk product. Nondairy milk is slightly acidic, having a PH's ranging from 6.1- 7. These slightly acidic nondairy milks are pea milk, soy milk, flaxseed milk, sesame milk, hemp milk, oat milk, and macadamia nut milk**.** Banana milk is made of fresh bananas with PH of 4.5-4.8 and dairy milk with PH of 6.7-6.9. The PH of banana milk varies depending on the amount of banana and the amount of dairy milk used in the mixture. Coconut milk has a PH ranging from 5.9- 6.3. Hazelnut and Cashew milk have a PH ranging from 4.19-6.45 depending on the ingredients added to the formulation, storage and processing. Their PH's decrease with increasing both amount of sweetener or sugar and with increasing storage time. Macadamia milk and sucrose sweetened walnut milk have a PH of 4.46-5. [78-89]

Table 6. Dairy and Nondairy Milk *78-89

Milk	PH
Dairy Milk	Mildly Acidic (6.4-6.9)
Pea Milk	Slightly Acidic (6.1- 7)
Soy Milk	Slightly Acidic (6.1- 7)
Flaxseed Milk	Slightly Acidic (6.1- 7)
Sesame Milk	Slightly Acidic (6.1- 7)
Hemp Milk	Slightly Acidic (6.1- 7)
Oat Milk	Slightly Acidic (6.1- 7)
Coconut Milk	Mildly Acidic (5.9- 6.3)
Hazelnut Milk	Highly to Moderately Acidic (4.19-6.45)
Cashew Milk	Highly to Moderately Acidic (4.19-6.45)
Macadamia Milk	Mildly Acidic (4.46-5)
Sucrose Sweetened Walnut Milk	Mildly Acidic (4.46-5)

* Different manufacturing processing of the nondairy milk results in slightly different PH of the milk product

3. Conclusions

Acidic foods are carbohydrates, grains, sugars, sweeteners, proteins, most fruits, dairy products and meats as they produce acidic byproducts once digested, sulfur and phosphorus, increasing the amount of acid in the body. Almost all vegetables are found to be alkaline, and only some were found to be acidic. Alkaline food, including most vegetables produce alkaline byproducts when digested: calcium, potassium and magnesium, increasing the amount of alkali (base) and decreasing amount of acid in the body.

Some seeds and nuts are found to be acidic while others are alkaline. Almost all oils are alkaline at room temperature, and they become acidic once exposed to air or heat. Margarine and butter are acidic. There are always some exceptions to the acidity and basicity of foods due to its texture being made of food products of different PH's. For example, bread is a carbohydrate, and is acidic in nature, but sprouted bread& wraps are alkaline due to the highly alkaline vegetable sprouts used in its making.

An acidic diet can be used if the if your blood (body's) PH is basic and a basic diet can be used if your blood PH is acidic to minimize and improve the symptoms and to improve the quality of life. Avoid acidic food if you have problems with acidity and avoid basic food if you have problems with basicity.

The recommended amount of fat, proteins and carbohydrates are 20-35%, 10-30% and 45-65% according to the United States Department of Agriculture. According to the CDC, the amount of nutrients is age and gender dependent, and the current mean intake of carbohydrates, protein and fat are: 47.4%, 15.7%, and 36.1% kilocalorie intake for adult women, and 45.9%, 16%, and 35.6% kilocalorie intake for adult men of the daily 2000 calorie intake.

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