Potassium and Heart Health

Research Project

Submitted to the department of (chemistry) in partial fulfillment of the requirements for the degree of BSc in (Education of Chemistry)

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Acknowledgments

Primarily, I would thank God for being able to complete this project with success. Then I will thank my dear Supervisor Mrs. Lutfia Hassan under whose guidance I learned a lot about this project. Her suggestions and directions have helped in the completion of this project. In addition, would like to thank my parents and friends who have helped me with their valuable suggestions and guidance and have been very helpful in various stages of project completion. Also , I want to thank Salahaddin University , Chemistry Department, which is always helpful for everything.

Finally, I want to thank all of those people who, once upon a time, were my teachers and who helped me begin this long journey.

CERTIFICATE:

This research project has been written under my supervision and has been submitted for the award of the BSc. degree in Chemistry with my approval as a supervisor.

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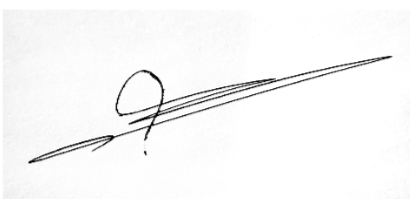
Date: / /2022

Signature



Abstract

Potassium is an electrolyte that your body, particularly your heart, neurons, and muscles, require in order to function properly. Potassium controls a variety of physiological functions, including muscle contraction, heartbeat, and the flow of nutrients and waste materials into and out of cells. The importance of potassium is highly underestimated. Because it is extremely reactive in water, this mineral is categorized as an electrolyte. It produces positively charged ions when dissolved in water. It has a unique feature that allows it to conduct electricity, which is critical for many bodily activities. Hypokalemia and hyperkalemia in heart failure is common because of heart failure itself, related comorbidities, and medications. Dyskalemia has important prognostic implications. Hypokalemia is associated with excess morbidity and mortality in heart failure. The lower the K+ levels, the higher the risk, starting at K+ levels below approximately 4.0 mmol/l, with a steep risk increment with K+ levels <3.5 mmol/l. Hyperkalemia (>5.5 mmol/l) has also been associated with increased risk of adverse events.

A potassium-rich diet has been linked to a slew of substantial health advantages. It may aid in the reduction of blood pressure and water retention, as well as the prevention of osteoporosis and kidney stones. This Research Paper provides a detailed review of potassium and what is does for your health .

Key Word: Potassium, Hemostasis, Heart

Table Of Contents

List of Figure:

List Of Table :

1. Introduction

Potassium is a metallic element, and symbol (k) and atomic number is 19, that is placed in the group 1 and row 4 of the periodic table, showed in Figure (1) and Table 1 . And oxidation state is +1 . State at 20°Solid ,and Bloc s . It is one of the most reactive and electropositive of metals. Except for lithium, it is the lightest known metal. It is soft, easily cut with a knife, and is silvery in appearance immediately after a fresh surface is exposed. It rapidly oxidizes in air and must be preserved in a mineral oil such as kerosene (Udensi & Tchounwou, 2017). As with other metals of the alkali group, it decomposes in water with the evolution of hydrogen. It catches fire spontaneously on water. Potassium and its salts impart a violet color to flames. The benefits of dietary potassium may be primarily through its effect on blood pressure. High dietary potassium is associated with a decrease in blood pressure, particularly in the context of a high-sodium diet (White & Karley, 2010). The Dietary Guidelines for Americans 2010 Advisory Committee recognized potassium as a nutrient in insufficient supply. The committee came to the conclusion that there was a moderate body of data linking potassium intake to lower blood pressure in adults, which affects the risk of stroke and coronary heart disease (Wearer, 2013). The preventive impact of appropriate dietary potassium on age-related bone loss and the decrease of kidney stones is also gathering evidence. Organic anions associated with potassium, which are found in foods such as fruits and vegetables, are responsible for these advantages (Hinsinger, 2020).

Table 1 : Some Information about Potassium Ion

Atomic Number	19
Atomic Symbolic	K
Atomic Weight	30.098
Electron Configuration	(Ar)4 s1

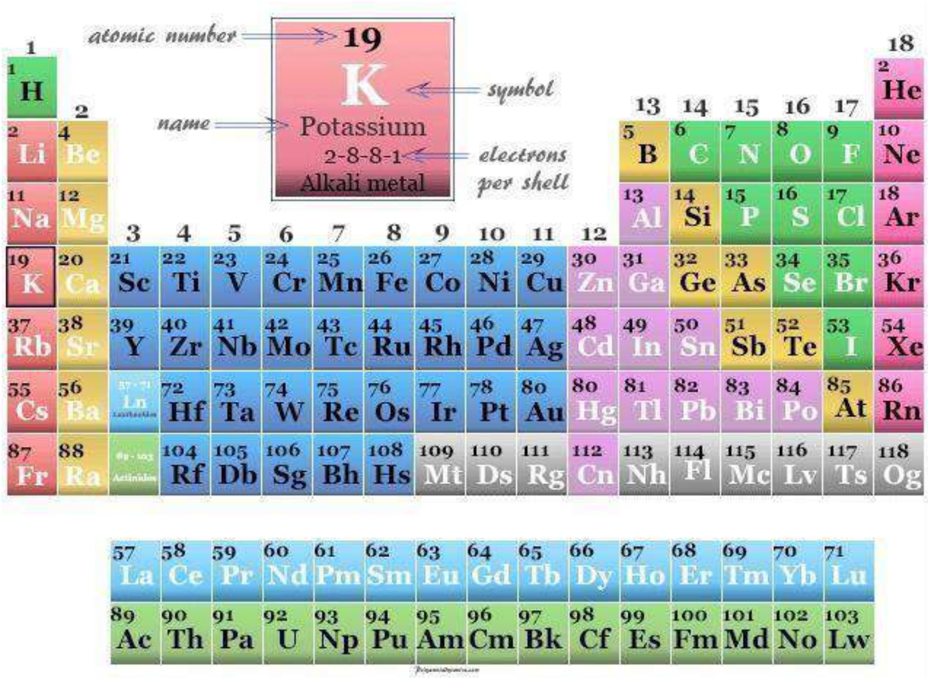


Figure 1 : Potassium in Periodic Table

1:1. History of Potassium

Saltpetre (potassium nitrate, KNO3), alum (potassium aluminum sulfate, KAl(SO4)2), and potash (potassium carbonate, K2CO3) are all potassium salts that have been known for centuries. They were used to make gunpowder, dye, and soap. They were scraped from latrine walls, made of clay and sulfuric acid, and collected as wood ash, respectively. Early scientists were unsuccessful in reducing them to the element, and Antoine Lavoisier classified potassium as a "earth."

The first metal to be separated by electrolysis was potassium. Sir Humphry Davy of England was the first to discover it in 1807. When he applied electrolysis to a small amount of melted potash, he discovered a tiny droplet of liquid metal, which he dubbed "potassium" from the word "potash." (Szabadvary, 2016).

1:2. Absorption of Potassium

The total amount of potassium in an adult's body is around 45 millimoles (mmol) per kilogram of body weight (around 140 g for a 175-pound adult; 1 mmol = 1 milliequivalent [mEq] or 39.1 mg potassium). The majority of potassium is found within cells, with only a little quantity found in extracellular fluid.

The intracellular potassium concentration is about 30 times greater than the extracellular potassium concentration, forming a transmembrane electrochemical gradient sustained by the sodium-potassium (Na+/K+) ATPase transporter (Turnberg, 1971). This gradient is necessary for correct nerve transmission, muscular contraction, and kidney function, in addition to maintaining cellular tonicity. Potassium is absorbed predominantly through passive diffusion in the small intestine , showed in Figure (2). About 90% of ingested potassium is absorbed and used to keep intracellular and extracellular potassium concentrations normal. Potassium is predominantly eliminated in the urine, with some being expelled in the feces and a small quantity being lost through sweat. Potassium excretion is controlled by the kidneys in response to variations in dietary intakes, and in healthy people, potassium excretion increases rapidly after eating until body stores are depleted. In healthy people, the kidneys can adapt to varying potassium intakes, but a minimum of 5 mmol (approximately 195 mg) potassium is expelled daily in urine. This, together with other mandatory losses, shows that potassium balance cannot be attained with daily intakes of less than 400–800 mg (Leddin, 1992).

Indirect evidence suggests that potassium is distributed simply passively across the mucosa of the small bowel. Thus after a meal its concentration in luminal contents of jejunum and ileum is close to plasma concentrations and isotonic electrolyte solutions equilibrate in the lumen of the small bowel at a similar potassium concentration (Agarwal, *et al*, 1994).

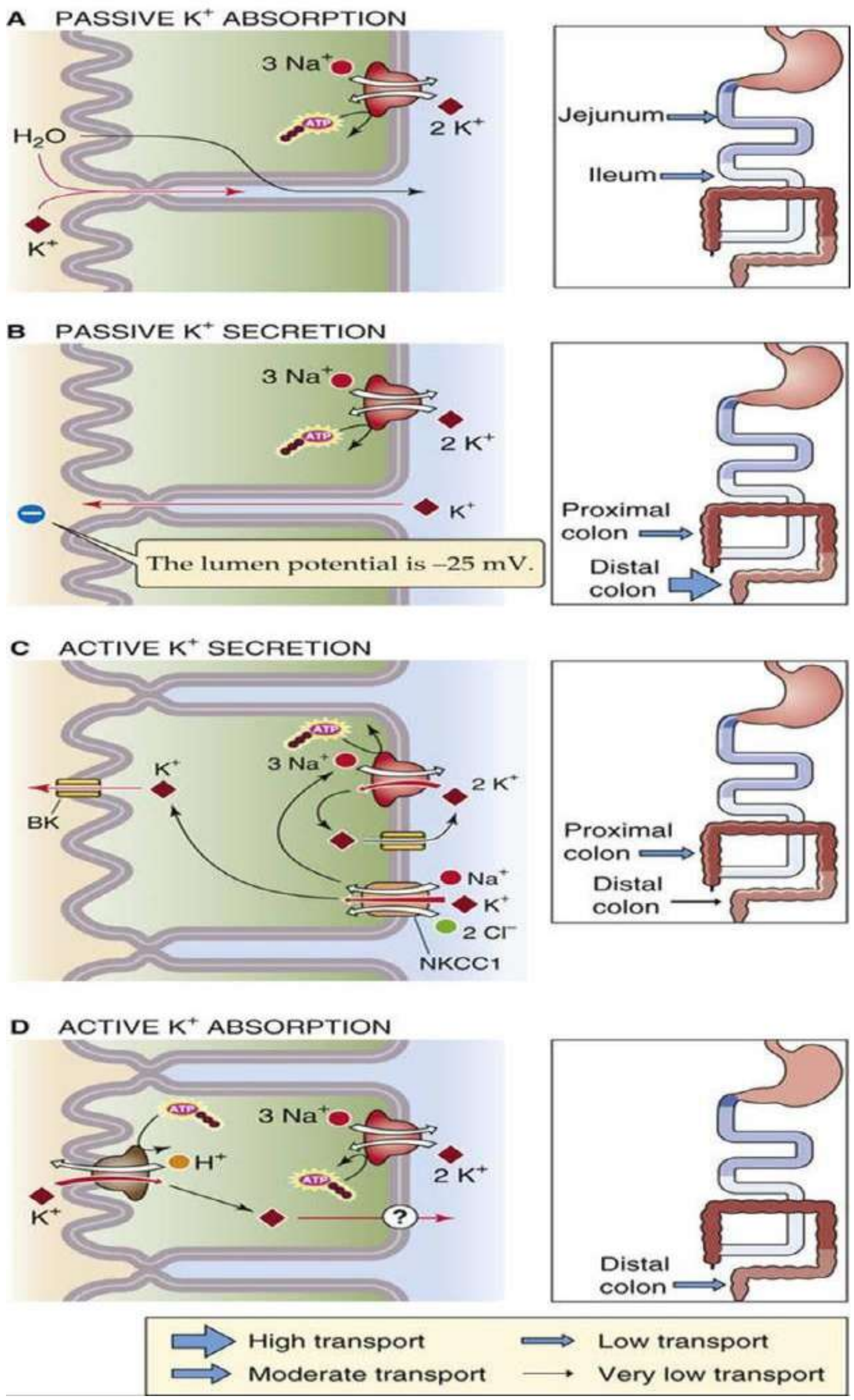


Figure 2 : Absorption of Potassium

1:3. Potassium Hemostasis Mechanism

Potassium homeostasis entails potassium redistribution between ICF and ECF cells. One of the ways the body's potassium balance is maintained is by controlling the transfer of potassium from intracellular to extracellular space. When potassium is lost through the renal system, the body pushes out cellular potassium, preventing the expected decline in plasma potassium level. Potassium intake, renal excretion, and gastrointestinal loss are all important in maintaining potassium homeostasis (Palmer, 2015).

The sodium and potassium pump (Na+-K+-ATPase), has a significant impact on potassium homeostasis. Sodium ions (Na+) are pumped out of the cell and potassium ions (K+) are pumped into the cell by the Na+-K+-ATPase, which is located in the membrane of practically all mammalian cells (Palmer & Clegg, 2016). This pump maintains the K+-balance between the ICF and ECF mostly through buffering, which entails ATP hydrolysis to create energy, with two K+ delivered inside for each ATP hydrolyzed and three Na+ pushed out of the cell for each ATP hydrolyzed. This establishes an electrical gradient by maintaining high Na+ in the ECF and high K+ in the ICF. When the number of Na+ leaving the cell exceeds the number of K+ entering the cell, the cytoplasm becomes negatively charged (i.e. more positive charged ions leave the cell). For nervous system function and muscular contraction, this electrical gradient is used in neurons and muscles. The exchange of K+ and Na+ has an impact on K homeostasis (Gumz, *et al*, 2015).

Renal K+ secretion is stimulated when the body needs to retain more Na+, resulting in an increase in Na+ supply and reabsorption by the distal nephron. On the other hand, this forces passive K+ outflow over the apical membrane. Extra renal processes affect normal potassium homeostasis in addition to K+ loss through the renal system. Potassium uptake by the liver and muscle in general, as well as intestinal potassium secretion, are examples of extra renal mechanisms. Acute potassium tolerance is regulated by extra renal tissues, but chronic potassium homeostasis is managed by the kidneys. Insulin, epinephrine, aldosterone, and glucocorticoids are among the hormones involved in maintaining appropriate extra renal potassium levels, (As shown in Figure 3). These hormones enhance potassium uptake by the liver and muscle (Rabinowitz, 1996).

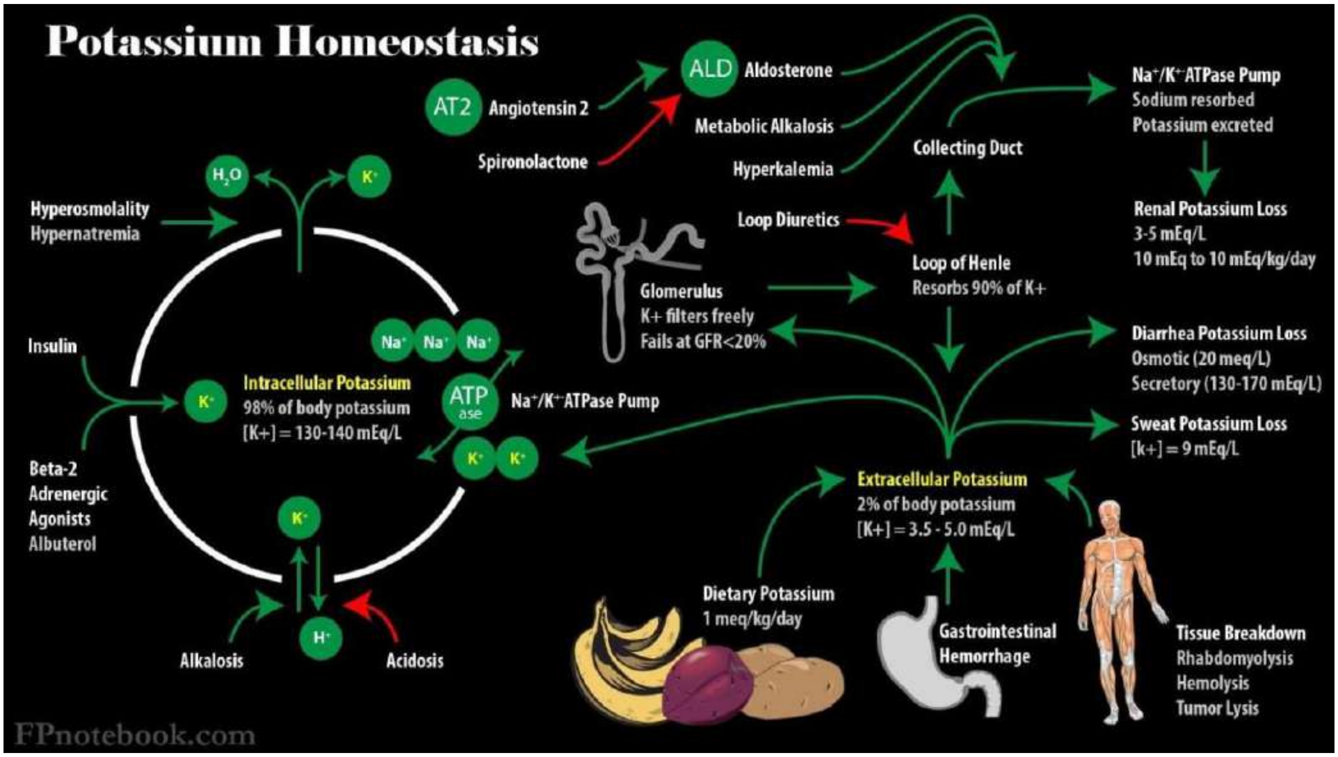


Figure 3 : Potassium Hemostasis Mechanism

1:4. Potassium Transport

Potassium (K+) accounting for 98 per the total pool in cells at 140-150 mmol/l and just 2% in the extracellular fluid, where it ranges between 3.5 and 5 mmol/l. The intracellularextracellular gradient must be finely regulated in order for life to exist (Kawahara, 1997). In cellular physiology, the sodium-potassium pump is a protein found in many cells that keeps the internal concentration of potassium ions [K+] greater than that of the surrounding medium (blood, bodily fluid, or water) while keeping the internal concentration of sodium ions [Na+] lower. External [K+] and internal [Na+] activate the pump, which has adenosine-triphosphatase (ATPase) action and traverses the cell membrane. This enzyme transports Na+ forth and K+ inward using metabolic energy. The steady state differential in Na+ and K+ concentrations maintained by the pump determines the resting potential of cells and related bioelectric phenomena such as the action potential, showed in Figure 4. Active potassium transport into and out of cells is essential for cardiovascular and neuronal function. A sodium-potassium exchange occurs across the cell membrane when potassium enters the cell. This generates the electrical potential in nerve cells, allowing nerve impulses to be transmitted. When potassium exits the cell, it restores the cell's repolarization, allowing the nerve impulse to continue (Henslee, *et al,* 2017).

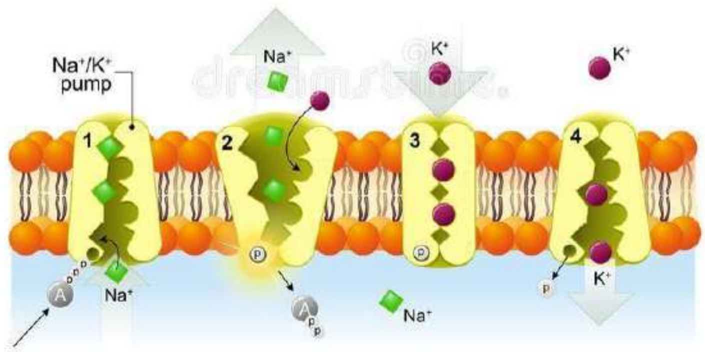


Figure 4 : Potassium Transport

1:5. Na, K- ATPase

Na,K-ATPase is an integral membrane protein that mainly functions as an ion pump, hydrolyzing one molecule of ATP to pump three Na+ out of the cell in exchange for two K+ entering the cell per pump cycle. This function is crucial to maintaining the ion gradient across the membrane and is critical for the resting membrane potential, electrical activity of muscle and nerve, Na+-coupled transport, and osmotic balance and cell volume regulation (Kaplan, 2002). Besides being an ion pump, Na,K-ATPase acts as a signal transducer (Pierre and Xie, 2006). Showed in Figure 5 which both alfa and β-subunit associate with various signaling molecules, including Src, phosphoinositide 3-kinase (PI3K), caveolin-1, protein phosphatase 2, and EGFR thereby activating a number of intracellular signaling pathways, including MAPK and Akt signaling, to modulate cell polarity, cell growth, cell motility and gene expression. Na,K-ATPase also functions as a receptor for the cardiac glycoside ouabain, a specific inhibitor of the pump (Kimura et al., 2011).

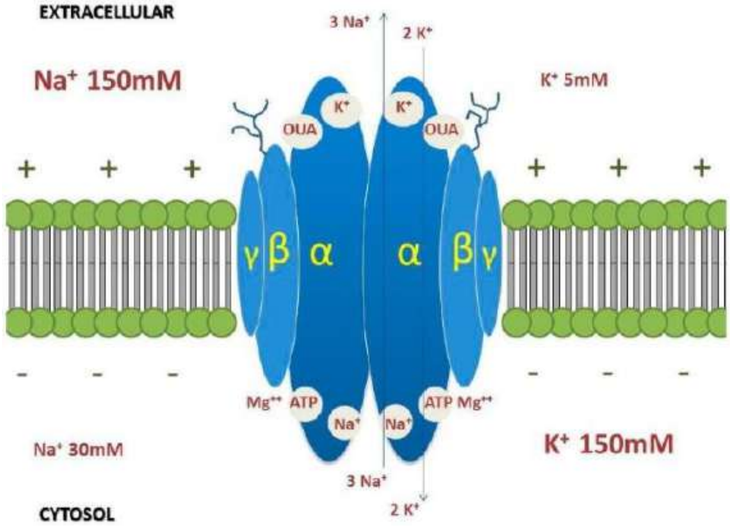


Figure 5 : Na, K ATPase Pump

1:6. Functions of Potassium in Human Body

- Essential for muscle contradictions
- Transmission of nerve signals
- Regulates water balance
- Cell function
- Role in kidney function
- Role in heart function
- Supports normal blood pressure
- Helps digestion of food
- Maintains fluid levels inside cells (Kowey, 2019).

1:7. Potassium and Health Benefits

1. Helps Slow Osteoporosis

As you become older, brittle bones become increasingly common. In the United States, people eat a lot of meat and dairy, which causes acidity in the bones. Acidity might cause your bones to deteriorate more quickly. Potassium-rich meals, such as fruits and vegetables, can help maintain bones and decrease the progression of osteoporosis by neutralizing acidity. (Wearer, 2013)

2 . Decreases the Risk of Kidney Stones

Mineral deposits build up in the kidneys, causing kidney stones. Kidney stones are more likely to form when tissue acidity is high. This acidity is increased by eating meat. Eating potassium-rich meals lowers acidity and enables calcium to stay in the bones, reducing the risk of kidney stones.(He & MacGregor, 2008)

3. Helps Your Muscles Work

To facilitate muscular function, you need enough potassium inside your cells and sodium outside of them. You may suffer muscle weakness or spasms if your sodium or potassium levels are out of equilibrium. (Wearer, 2013)

4. Decreases the Risk of High Blood Pressure

High blood pressure causes your veins and arteries to be stressed. It raises your chances of getting heart disease, cardiac failure, and stroke. Excess sodium can aggravate high blood pressure, whereas potassium helps the body remove salt and relaxes blood arteries. (Carretero, 2002)

5. Helps Prevent Strokes

In the event of a stroke, your brain's blood supply is cut off or restricted. Strokes are usually caused by ruptured or clogged blood arteries. High blood pressure is linked to some strokes, thus getting enough potassium and controlling blood pressure may be beneficial. (He & MacGregor, 2008)

6. Regulates Neural Function

Potassium channels are important for maintaining the brain's electrical conductivity and have a significant impact on brain function. It also plays a role in higher-order cognitive functions such as memory and learning. Furthermore, diseases like epilepsy are linked to potassium channel malfunction, which can be caused by a deficit. (Wearer, 2013)

7. Boosts Metabolism

Potassium aids in the metabolic breakdown of lipids and carbs, among other nutrients. As a result, it is extremely useful in extracting energy from the nutrients absorbed. also has a role in protein synthesis, which has an impact on tissue regeneration, cell proliferation, and overall metabolism balance. (He & MacGregor, 2008)

8. Regulates the Level of Fluids

In the human body, potassium is an important electrolyte. It aids in a number of vital biological activities by regulating the volume of fluids in the body. (Carretero, 2002)

9 . Cardiovascular Health

Low potassium intakes are linked to an increased risk of hypertension (high blood pressure), especially when associated with high salt intakes, according to a large body of research. Overall, the data suggests that increasing potassium intake can help lower blood pressure and avoid strokes, as well as other types of cardiovascular disease (CVD). (Carretero, 2002)

10. Stabilizes Blood Sugar

Lower potassium levels have been linked to an increased risk of diabetes in studies. In persons who were otherwise healthy, a study discovered a relationship between high insulin/glucose levels and low potassium levels. (He & MacGregor, 2008)

1:8. Dietary Sources of Potassium and Recommended Dietary Allowance

Potassium is widely available in many foods, especially fruits and vegetables, showed in Figure 6.

Foods Lower In Potassium

Vegetables : Beans, Cabbage , Broccoli , Carrots, Celery, Corn, Cucumbers , Spinach , Tomato, Zucchini, Radish, Mushroom , Eggplant , Fennel, Peas, Okra, Onions, Collard Greens, Potato, Parsley, Peppers , Turnip.

Fruits : Apple, Blackberry , Blueberry , Coconut , Crab Apple, Figs, Grape, Honeydew , Lemon, Pear, Peach, Pineapple , Pomegranates , Prunes, Raspberries , Watermelon.

Foods Higher In Potassium

Vegetables : Amaranth, Artichokes, Bamboo Shoots, Beet Greens, Bok Choy, Brussels , Carrot Juice , Choy Sum, Gailan, Garden Cress, Lotus Root, Okra, Parsnips , Whole Boiled Potatoes , Pumpkin, Sweet Potatoes , Sword Beans, Tomato Paste.

Fruits : Avocado , Bananas , Bael Fruit, Apricot , Cantaloupe , Coconut Milk, Guava, Jackfruit, Kiwi Fruits , Nectarine , Oranges , Papaya, Plantain, Prickly Pear, Pummelo, Raisins, Tangelo.

Other foods high in potassium

Grain Product, Milk Products, Nuts and Seeds, Beans and Lentils, Beverages (Like Black Tea and Coffee) Candy And Sweetener (Like Chocolates), Chicken, Salmon. Daily requirements showed in Table 2, (Bolton, *et al* , 2019).

Table 2 : Potassium Requirements Daily

Age	Male	Female	Pregnant	Lactating
0-6 months	400 mg	400 mg		
7-12 months	700 mg	700 mg		
1-3 years	3000 mg	3000 mg		
4-8 years	3800 mg	3800 mg		
9-13 years	4500 mg	4500 mg		
14-18 years	4700 mg	4700 mg	4700 mg	5100 mg
19-50 years	4700 mg	4700 mg	4700 mg	5100 mg
51-70 years	4700 mg	4700 mg		
70+ years	4700 mg	4700 mg		

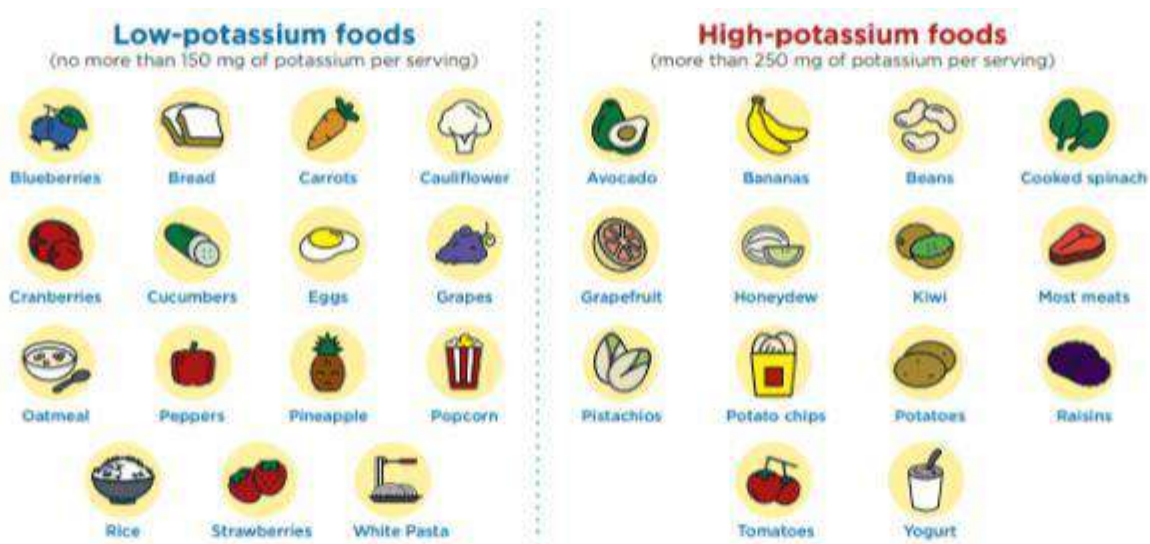


Figure 6 : Potassium Food Sources

1:9. Pathology of Potassium Intake

1. Hypokalemia

Hypokalemia is a common occurrence in clinical practice. Hypokalemia can be caused by cell shift in the short term, but it can also be caused by insufficient intake or excessive K+ loss in the long term. Excessive K+ loss can result in hypokalemia, which can be caused by renal or extrarenal losses. A clinical history and physical examination can be used to determine the reason and source of hypokalemia, with special emphasis devoted to the patient's volume and acid base status. Renal K+ excretion assessment allows for determination as to whether hypokalemia is due to renal or extrarenal causes. A 24-h urine collection or a spot urine can be used to assess renal K+ handling. A 24-h urinary K+ of <20 mEq, or a spot urine K+ (mmol)/creatinine (mmol) ratio <1, suggests an extrarenal cause of hypokalemia.

Decreased Potassium Intake

Hypokalemia can be caused by dietary K+ restriction; however, in most cases, dietary restriction exacerbates hypokalemia caused by other factors. In reaction to a K+-free diet, the kidney can only reduce urinary K+ to 15 mEq/d, despite the fact that it can construct urine nearly free of Na+ in response to dietary Na+ restriction. Clinical conditions linked to K+ shortage include anorexia nervosa, crash diets, drunkenness, and intestinal malabsorption.

Cellular Distribution

Because renal K+ excretion might take many hours after a K+ load, fluctuations in extracellular K+ concentrations are first buffered by K+ transport into or out of skeletal muscle. Furthermore, postprandial insulin release not only regulates blood glucose concentrations, but also shifts dietary K+ into cells until the kidney excretes the K+ load, restoring normal total body K+ content.

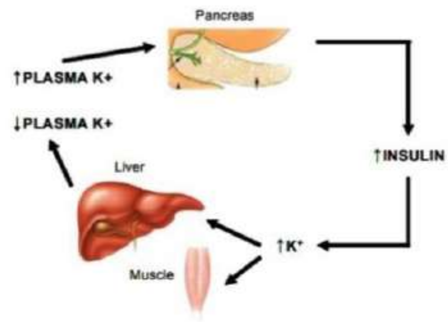


Figure 7 : Feedback loop relating changes in plasma potassium concentration to changes in insulin secretion by the beta cell

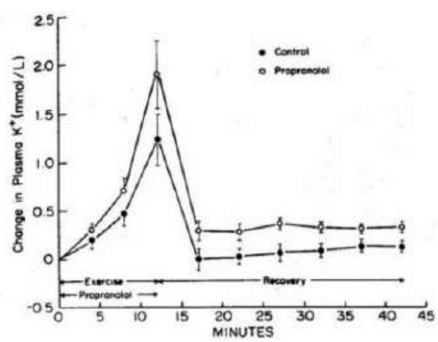


Figure 8 : Effect of propranolol on the rise and fall of plasma potassium during and after exercise adapted from Williams ME, Gervino EV, Rosa RM, Landsburg L, Young JB, Silva P, Epstein FH. Catecholamine modulation of rapid potassium shifts during exercise. N Engl J Med 312:823-827, 19

Extrarenal K+ loss.

Extrarenal or renal losses might cause a decrease in total body K+. Cutaneous K+ loss sufficient to cause hypokalemia is uncommon; however, it can happen during intensive exercise in a hot, humid environment when substantial amounts of perspiration are produced, resulting in K+ depletion. The most common clinical manifestations of extrarenal K+ depletion are gastrointestinal symptoms (Palmer & Clegg, 2015).

2. Hyperkalemia

Hyperkalemia is defined as a serum potassium concentration greater than approximately 5.0-5.5 mEq/L in adults; the range in infants and children is age-dependent.

Increased dietary intake.

In the presence of normal renal and adrenal function, ingesting enough K+ to become hyperkalemic is challenging. Dietary consumption is frequently a contributor to hyperkalemia when renal function is impaired. Melons, citrus juice, potatoes, avocado, and salt alternatives are only a few examples of popular dietary sources high in K+ that should be avoided by hyperkalemia sufferers.

Cell Shift

Hyperkalemia is caused by cellular redistribution rather than hypokalemia. It's vital to remember that even a 2% shift in intracellular K+ to the extracellular fluid results in a serum K+ of 8 mEq/l. Serum K+ concentration changes caused by cell shifts are usually temporary, whereas chronic hyperkalemia is caused by decreased renal clearance. Depending on the type of acid present, metabolic acidosis facilitates K+ escape from cells. Mineral acidosis generates the most K+ efflux from cells, but organic acidosis has little effect on K+ outflow.

Impaired renal excretion.

The occurrence of simultaneous reductions in renal K+ excretion is implied by prolonged and severe hyperkalemia. In most cases, the clinician will be able to assess whether or not there is a problem with renal K+ excretion in the clinical environment. Reduced K+ excretion in the kidneys can be caused by one or more of three conditions: decreased distal Na+ supply, mineralocorticoid shortage, and/or aberrant cortical collecting tubule function, all of which will be addressed in greater detail below (Palmer & Clegg, 2019).

2. Potassium and Heart Health

Potassium is involved in each and every heartbeat. It helps your heart squeeze blood through your body a hundred thousand times per day. Potassium has no effect on the treatment or prevention of heart disease. However, receiving enough of it can benefit your heart in a variety of ways:

- Better blood pressure: A diet rich in fruits, vegetables, and fat-free or low-fat dairy items can help persons with high blood pressure lower their systolic blood pressure by more than 10 points.
- Lower cholesterol: While there is no direct link between the two, many cholesterollowering diets include plenty of potassium as well as fruits and vegetables. If you lower your LDL (bad cholesterol), your chances of developing heart disease decrease.
- Regulated heartbeat: Potassium enables your heart to beat in a healthy way. So, if you're having trouble with your rhythm, potassium might be the answer. That is something your doctor can help you with. A checkup could be included in your regular doctor visits (Tunstall, 1999).

2:1. Role of Potassium in Cardiac Muscle Contraction

Potassium is essential for heart function, and low amounts in the body (hypokalemia) cause irregular contractions and abnormal electrocardiograms, among other issues. An electrocardiogram, or ECG, is a test that assesses cardiac function, specifically contraction force and rate. Potassium is required for voltage-gated potassium channels to function in cardiac muscle cell outer membranes. These channels open in response to a voltage shift and are in charge of ending action potentials and contractions as well as initiating repolarization. Hyperkalemia, or having too much potassium in the body, causes poor electrical conduction, which can result in palpitations and a messed-up heart rhythm. (He & MacGregor, 2008).

2:2. Cardiac Implications of Potassium

K+ is essential for maintaining cardiovascular health, and maintaining a normokalemic condition is crucial for avoiding potentially significant consequences, particularly in atrisk cardiovascular patients. Hypokalemia can be caused by a variety of reasons, including endogenous and exogenous catecholamine activity, activation of the Renin-angiotensinaldosterone system, and/or the use of potent K+ wasting diuretics. In this sense, K+ wasting diuretics are interesting because their use can result in substantial K+ or Mg++ deficiency, or both. Hypokalemia caused by diuretics is dose-dependent and connected with the amount of volume depletion and/or the elevation in circulating serum catecholamine levels. Diuretic treatment, on the other hand, has been demonstrated to minimize coronary heart disease occurrences in hypertensive patients, despite the fact that some decreases in K+ levels may occur and that they may have a short term adverse effect on glucose and lipid metabolism (Podrid, 1990).

2:3.Hypokalemia and Heart Health

The intracellular cation potassium is the most abundant. The normal potassium level in the blood is between 3.5 and 5.5 mEq/L. This is significantly less than intracellular levels, which range from 140 to 150 mEq/L. The resting membrane potential and the time of membrane depolarization are both determined by the distribution of potassium levels across cellular membranes. As a result, variations in serum potassium levels have the greatest impact on organ systems that rely heavily on membrane depolarization for function (Gennari, 1998).

The resting membrane potential rises with hypokalemia. The refractory periods and action potentials are both prolonged. Symptoms do not usually appear until potassium levels fall below 3.0 mEq/L. Hypokalemia should be suspected based on the following signs and symptoms:

Symptoms of the heart:

- T wave flattening
- ST depression
- Arrhythmias -U wave appearance

Skeletal and smooth muscle manifestations:

- Hypotonia and muscle weakness
- Respiratory depression
- Muscle cramps
- Constipation and/or ileus
- Rhabdomyolysis and myoglobinuria (Helfant, 1986)

2:4 Congestive Heart Failure and Potassium

Hypokalemia is frequent in CHF patients, which is caused by physiologic abnormalities that contribute to the development of electrolyte problems. Low serum potassium levels were linked to sudden cardiac mortality in the UK Heart Failure Evaluation and Assessment of Risk study. In certain studies, patients with hypertension who were receiving nonpotassium-sparing diuretics had a two-fold increased risk of sudden cardiac mortality compared to those who were on potassium-sparing treatment(Tunstall, 1999).

2:5. Mechanisms for Hypokalemia - Induced Triggered Arrhythmias

Hypokalemia has been linked to induced arrhythmias like Torsades De Pointes (TDP), polymorphic VT, ventricular fibrillation (VF), and ventricular ectopy in clinical studies. Hypokalemia causes triggered arrhythmias in cardio myocytes via reducing cardiac repolarization reserve and increasing intracellular Ca2+. We evaluate the evidence for processes linking hypokalemia to the onset of triggered arrhythmias and conclude that inhibition of NKA (particularly the NKAa2 isoform) leads to the formation of after depolarization's (Podrid, 1990)

(1) Low K+ reduces the activity of the NKAa2 isoform. (2) Intracellular Na+ accumulates and leads to reduced inward NCX current, and by this less extrusion of Ca2+. (3) Intracellular and SR Ca2+ increases as a result. (4) Ca2+ overload increases the activity of the Ca2+/calmodulin-dependent kinase (CaMKII), which leads to a vicious cycle by phosphorylation of voltage-gated Na+ channels and L-type Ca2+ channels.(5) Increased influx of Na+ and Ca2+ amplifies Ca2+ overload and triggers EADs. (6) Hypokalemiainduced EADs can trigger ventricular tachyarrhythmias , as shown in Figure 9. (Skogestad & Aronsen, 2018).

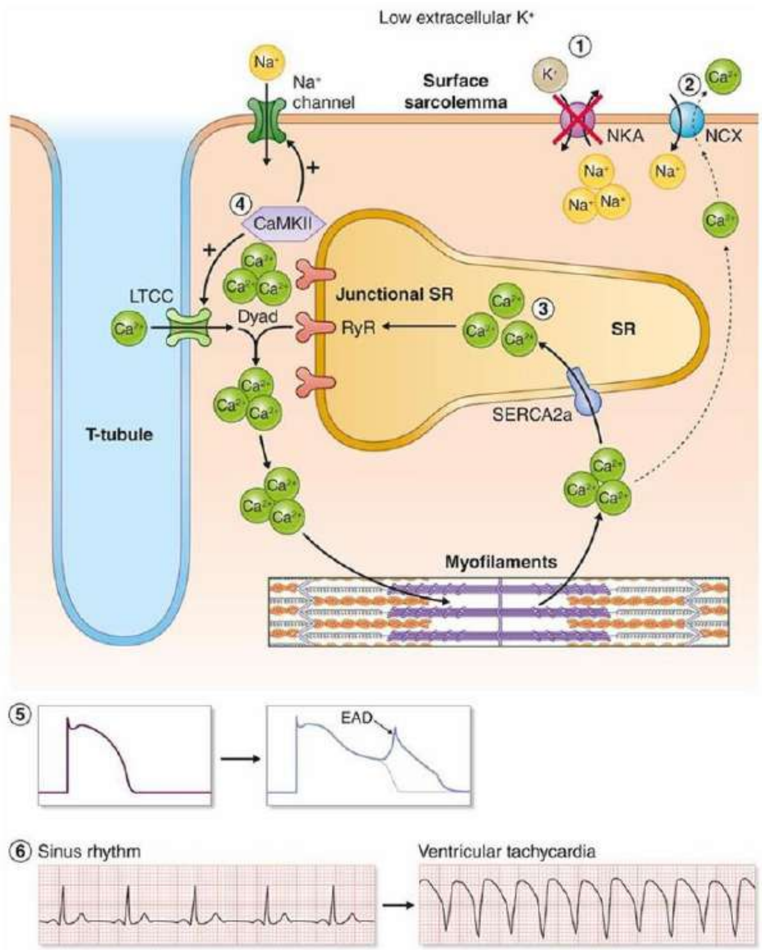


Figure 9 : Mechanisms for Hypokalemia - Induced Triggered Arrhythmias

2:6. Hyperkalemia and Heart Health

The resting membrane potential is reduced in hyperkalemia, and the membrane becomes partially depolarized. This enhances membrane excitability at first. Long-term depolarization, on the other hand, makes the cell membrane more refractory and makes it less likely to fully depolarize. The following signs and symptoms of hyperkalemia should be taken seriously:

Symptoms of the heart:

- Peaked T waves\s-Shortened QT interval\s
- Prolonged PR interval\s
- Flattening of P wave\s
- Widened QRS interval\s
- Bundle branch and atrioventricular conduction blocks
- Arrhythmias

Skeletal muscle manifestations:

- Ascending muscle weakness\s
- Flaccid paralysis (Aburto, *et al*, 2013)

2:7. Treatments of Hypokalemia and Hyperkalemia

Low potassium levels are usually treated with potassium supplements. Potassium may be given as an intravenous (IV) solution if the situation is severe, for example:

- If you have a dangerously low potassium level,
- If taking potassium supplements does not result in an increase in potassium levels,
- If your low potassium levels cause abnormal heart rhythms

If the hypokalemia is caused by another illness, such as low magnesium levels or an overactive thyroid, the other ailment must be treated as well (Sweeney, 1999).

Intravenous calcium gluconate should be given to patients with hyperkalemia and characteristic ECG changes. Acutely reduce potassium levels by administering intravenous insulin with glucose, a beta2 agonist via nebulizer, or both. Sodium polystyrene sulfonate is commonly used to reduce total body potassium (Sterns, *et al*, 2016).

3.. Estimation and Determination of Potassium

1. The Flame Photometer

Potassium in biological fluids can be determined using a standard and easy approach. Emission flame photometry is a technique used to measure the amount of light emitted . This relies on the principle that an alkali metal salt is dragged into a non-luminous flame, it ionizes, absorbs energy from the flame, and then returns to its original state. The strength of the emission is related to the element's concentration in the solution. This is the basic principle of flame photometry. A photocell detects the light that is emitted and converts it to a voltage that can be measured.

2. Ion-selective Electrodes

Ion-selective electrodes (ISEs) are electrochemical ion sensors that convert a target ion's activity into a quantifiable electrical potential. In clinical laboratories they can be used to quantify Ca^{2+}, K^+, and Cl^- in body fluids (blood, plasma, serum, sweat), as well as F^- in skeletal and dental studies. They're also employed to measure a wide range of other ions in environmental investigations, for example. ISEs are cheap and easy to use when compared to many other analytical procedures. Have a linear reaction across a wide concentration range, unlike the flame photometer.

Hypokalaemia (lowered plasma [K+]), hyperkalaemia (increased plasma [K+]) and hyperkaluria (increased urinary excretion of K+) are again indicative of a variety of conditions and the clinical measurement of [K+] is also of great importance , normal ranges of potassium showed in Table 3, (Cooper, 1963).

Serum	3.5-5.1 mM
Cerebrospinal fluid	about 70% of serum
Sweat	4.0-9.7 mM (men) 7.6-15.6 mM (women)
Urine (varies with intake)	25-125 mmol/day
Erythrocytes (intracellular)	105 mM

Table 3 : Normal Ranges of Potassium

4.Conclusion

Potassium is a mineral that is necessary for regular cellular function. Despite the fact that humans originated on potassium-rich foods, modern diets are deficient in the mineral. Many of the negative effects of insufficient potassium intake, such as higher blood pressure, increased salt sensitivity, increased risk of kidney stones, and possibly increased bone loss, can be avoided by increasing K intake through meals. Increasing potassium consumption in the diet is thought to protect against stroke and may also reduce the incidence of CHD and total CVD. In clinical medicine, abnormalities of K+ homeostasis occur with considerable regularity. Hypokalemia and hyperkalemia are two examples of these disorders, each of which has its own set of symptoms. Furthermore, even in the context of a normal blood K+ content, pathophysiologic implications of lower dietary K+ consumption are being increasingly recognized. Hypokalemia causes triggered arrhythmias in cardio myocytes via reducing cardiac repolarization reserve and increasing intracellular Ca2+.

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