

# Potassium (Kalium)

**Symbol: K Group: I A Series: 4 Atomic number: 19 Atomic weight: 39**

## INTRODUCTION:

**Metallic Potassium (K)** was first isolated by Davy in 1808 by the electrolysis of fused potassium hydroxide. Potassium and Sodium are separated in the earth surface in the colloidal and fluid parts respectively. Similar separation also occurs in humans. Potassium salts are present in fertile soil, in combined state with organic acids in the plants, mineral springs and ocean. In nature, it occurs as carnallite, sylvine, kanite, saltpeter and in rocks as silicates.

Potassium ( $K^+$ ) ion is more reactive than sodium ( $Na^+$ ) ion. Alkali cations play a significant role in water regulation, acid-base equilibrium and colloidal state in the organism. It is principally intracellular colloidal content. It is a major determinant of the volume of the cell and Osmolality of the body fluid. It is slightly radioactive and emits  $\beta$  (beta) rays. It is used in photoelectric cells. Alloy of potassium and sodium, as a liquid, lowers the temperature, useful in various industries.

Concentration of  $K^+$  in whole blood- 200mg%, in plasma 20mg%, in corpuscles 440mg%, in muscles 250-400mg%.

**SOURCES:** Green and deep yellow leafy vegetables, potato, citrus fruits, milk, etc. Fat contains more of  $K^+$  (less of  $Na^+$ ), while cereals, bread, cheese, buttermilk contain less  $K^+$  (more of  $Na^+$ ). Mushrooms contain large amount of  $K^+$ .

**DAILY REQUIREMENT:** Infants (1 yr): 350 - 1275 mgm. Children + Adolescents 1 - 11 yrs: 550 - 4575 mgm. Adults: 1875 - 5625 mgm.

**ABSORPTION STORAGE AND EXCRETION:** Almost all Potassium ions are absorbed from GIT. It is freely

filtered at the glomerulus and almost completely reabsorbed at the proximal tubule of nephron. It is secreted in distal convoluted tubule of nephron as well as colon. Thus excretion occurs through urine and faeces.

Aldosterone stimulates Sodium ( $Na^+$ ) ion re-absorption and Potassium ( $K^+$ ) ion secretion, thus retention of Sodium  $Na^+$  and excretion of Potassium  $K^+$ . Potassium directly regulates aldosterone secretion independent of renin-angiotensin system.

## PATHO-PHYSIOLOGY:

- Potassium ( $K^+$ ) like all alkali ions, has great affinity for water and draws water to the place where K is in excess.
- It maintains intracellular pH and electrical excitability of nerves and muscles. Migration of chloride with other anions from intracellular to extracellular and vice versa, maintains ionic balance in the body.
- It is an excellent soporific.  $K^+$  predominant tissues are greasy (due to formation of soap from fat with  $K^+$ ) in appearance, while  $K^+$  deficient tissues become acidic tissues, which are dry and dark and form brownish spots or film over mucous membrane of mouth and throat.
- Sympathetic nervous system and aldosterone- control cellular and plasma concentration of  $K^+$ . Stimulation of beta-adrenergic receptor causes hypokalemia, of alfa receptor causes hyperkalemia.
- $K^+$  keeps fibrinogen in soluble state. Deficiency causes conversion of fibrinogen into fibrin and formation of fibrous tissues in the exudate that results into adhesion formation, esp in pleura, peritoneum, synovial membrane, meninges.

During health, optimal proportion of Sodium ( $Na^+$ ), Potassium ( $K^+$ ), Calcium ( $Ca^{++}$ ) and Magnesium ( $Mg^{++}$ ) in blood is 100 : 1.7 : 1.1 : 0.5. Hypo or hyper level of any one disturbs the functions of all others, which result

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into disease.

Decreased level of  $K^+$  ions is called hypokalemia. Increased level is Hyperkalemia.

### HYPOKALEMIA:

**Cause:** Deficiency of ADH; increased level of aldosterone, mineralo-corticoids, gluco-corticoids; poor intake of food, diarrhoea, vomiting, starvation, diuretics (except spironolactone, triamterene and amiloride), Hypertension, diabetic ketoacidosis, Insulin, stimulation of beta adrenergic receptor, Barter's syndrome, renin secreting renal tumors, licorice (as it contains mineralo corticoid compound), Cushing Syndrome, steroid toxicity, monocytic or myelo monocytic leukaemia, Lysozymuria, Penicillin G, amino-salicylic acid,  $Mg^{++}$  deficiency, chronic abuse of laxatives. Mucus secreting villus adenomas of small intestine, excessive sweating, excessive NaCl in metabolic alkalosis, etc.

Alkalosis and hypokalemia may occur together.  $K^+$  and  $Cl^-$  deficiency co-exists.

$K^+$  decreases primarily due to increased renal excretion.

POTASSIUM EXCRETION is stimulated by 3 mechanisms:

1. Loss or deficiency of gastric acid leads to metabolic alkalosis, which increases renal tubular  $K^+$  secretion and thus excretion.
2. Elevated plasma bicarb concentration leads to polyuria along with bicarbonate and  $K^+$  excretion.
3. Secondary hyper aldosteronism causes  $K^+$  excretion despite  $K^+$  depletion.

**CLINICAL FEATURES:** During Potassium ( $K^+$ ) deficiency cell membrane loses capacity to maintain normal ingredients as seen in uraemia, thyrotoxicosis, severe and prolonged hypoxia, with simultaneous decreased functions of adrenal cortex & pancreas (reduces tolerance to carbohydrate).

**1. Paresis to paralysis:** Neuro muscular weakness and decreased motor power. Decreased or absent tendon reflexes. Degeneration or paralysis of skeletal muscles. Rhabdomyolysis.

**2. Heart:** Hypokalemia causing hypertension suggests hyper-aldosteronism and gluco-corticoid excess (In other cases BP is normal).

Patchy necrosis of sub endocardial region and myocardial dysfunction.

**E.C.G Changes:** Flattening and inversion of 'T' waves. Increased prominence of 'U' wave and sagging (depression) ST segments, prolongation of QT interval, defect in conduction and cardiac arrest. ( $K^+$  deficiency with hypocalcemia enhances cardiac toxicity of digitalis preparation).

**3. Kidney:** Renal tubular function is impaired. Decreased concentrating ability of renal tubule, which may cause polyuria and polydipsia. Protein excretion in urine is normal or minimally increased and urinary sediment is normal or slightly increased in hyaline or granular cast. Urine is alkaline or has neutral pH in  $K^+$  deficiency. Renal synthesis of prostaglandin increases.

**4. Metabolism:** Deficiency of  $K^+$  causes slow breakdown of glycogen and increased fat mobilisation resulting into fatty infiltration or waxy degeneration. Diabetes: Tolerance to carbohydrate is reduced. Polyuria and polydipsia.

**5. Intestinal dilatation of ileus.**

**6. Hypokalemia and hypocalcemia may occur together in Mal-absorption Syndrome.** The abnormal neuro-muscular effect of one electrolyte is masked by other. Treatment of either disorder alone may precipitate other. Thus by treatment of hypokalemia alone may precipitate tetany and conversely treatment of hypocalcaemia without correcting hypokalemia may exacerbate manifestation of  $K^+$  deficiency.

**7. Intracellular as well as extracellular decrease in potassium causes increased sodium ions per unit volume.** To balance this cationic change, imbibition and retention of water takes place. Therefore, increases the intra as well as extra cellular volume. This results in oedema formation in the tissues, lungs, brain, extremities, abdomen, scrotum, pericardium.

pleura, etc. of transudatory type.

### HYPERKALEMIA: CAUSES:

#### 1. Inadequate excretion

(a) renal failure: (i) acute (ii) severe chronic renal failure (iii) tubular disorder.

(b) Hormones: Adrenal insufficiency, insulin deficiency hypoadosteronism, Addison's disease;

(c) Diuretics, which inhibit  $K^+$  secretion (Spironolactone, Triamterene, Amiloride)

#### 2. Shift of $K^+$ from tissue:

a. Tissue damage (muscle crush, haemolysis, internal bleeding), trauma, burns. Anuria patient with tissue damage increases  $K^+$  levels rapidly. It is an important cause of death in military casualties.

b. Drugs (muscle relaxant, Succinyl choline, beta-adrenergic blocker, Arginine, Digitalis poisoning).

c. Metabolic acidosis.

d. Neuro muscular diseases like paralysis, paraplegia, and multiple sclerosis.

3. Excessive intake of  $K^+$  (oral or intravenous).

4. Pseudo hyperkalemia: a) Thrombocytosis.

b) Leucocytosis. c) Poor vein-puncture technique.

d) In vitro haemolysis, blood clotting, severe acute infection.

Adrenal and pancreas control  $K^+$  ion over load. When the function of both glands is decreased, person may be predisposed to hyperkalemia. Hyperkalemia stimulates the secretion of Glucagon and release of insulin from pancreas. Insulin in turn facilitates the cellular intake of  $K^+$  in muscles and lowers plasma  $K$  levels.

$K^+$  and  $H^+$  ion concentrations are higher in the intracellular than extracellular. When acidosis occurs i.e. when  $H^+$  increases extracellularly,  $K^+$  comes out from the cell in the extracellular fluid and hyperkalemia occurs. Cells die. And reverse occurs in hypokalemia in extracellular alkalosis,  $H^+$  with water enters in the cell. Cells swell become fragile and die.

### CLINICAL FEATURES:

1. **Heart:** Cardiac arrhythmia. ECG: high pick T waves, especially prominent in precordial leads. T wave

increases in height and is tented. Prolongation of PR interval (P wave ultimately disappears). Complete heart block and atrial asystole. QRS complex is progressively prolonged and finally tends to merge with T wave in a sine wave configuration. Terminally ventricular fibrillation and standstill may occur. Heart stops beating in diastole. Heart is darkly coloured and blood contains more of carbonic acid. Pulse rate decreases.

(Hypokalemia: E.C.G Changes: Flattening and inversion of 'T' waves. Increased prominence of 'U' wave and sagging (depression) ST segments, prolongation of QT interval, defect in conduction and cardiac arrest.)

Impulse generation & conduction in all cardiac tissues are decreased. Widening of QRS complex. Asystole (diastole) occurs.

2. **CNS:** Ascending muscular weakness, progressing to flaccid quadriplegia and respiratory paralysis. Cerebral and cranial nerve functions and sensations are normal.

### 3. HYPOTHYROIDISM.

#### COMMON MEDICINES IN KALI GROUP:

*Kali-arsenicum, Kali-bichromicum, Kali bromide, Kali-carbonicum, Kali-chloratum, Kali-cyanatum, Kali-hydroiodide, Kali-muriaticum, Kali-nitricum, Kali-phosphoricum, Kali-sulphuricum*

#### COMMON INDICATIONS OF KALI GROUP:

Ailments from: Suppression of emotion, menses and gonorrhoea; disappointment, fright, fit of passion, over study, mental exertion; loss of vital fluid, masturbation, abuse of sex; thunder storm, over eating, fat, salt, bread, sugar, milk, quinine, wine, etc.

1. **DIRECTION OF ACTION:** *Kali* ( $K^+$ ) has centripetal action. The cause lies within the body, and disease symptoms develop from periphery to center.

2. **MIASM:** Psoric, sycotic, tubercular & syphilitic.

3. **CONSTITUTION:** *Kali* person is obese, oedematous, bulky, fatty and flabby without fitness. His skin is dark brown to black in colour, soft and smooth like wax.

4. **INFLAMMATION AND PAIN:** Non-inflammatory, painless<sup>3</sup> (in dynamic doses).



During painful and inflammatory conditions, it will be useful in physiologic doses. Pain is burning, stitching, sharp, cutting, spotty, migrating, radiating, type.

**5. SPHERE OF ACTION:** CVS: Heart: Potassium ( $K^+$ ) acts predominantly on heart where it produces typical ECG changes. Patchy necrosis and disturbance in conduction.

Blood: Anaerobic oxidation in RBC Leucocytosis.

Skeletal muscles: Paralysis and degeneration.

Nervous system: Degeneration of grey matter.

Serous and mucous membranes: Oedema and adhesion formation.

Epithelial cells, connective and areolar tissue: Swelling and loss of elasticity.

Skin: Dry, greasy and sticky. Dry eczema and warts.

**6. TONGUE, TASTE AND DISCHARGES:**

Tongue: It is soft, swollen, flabby, thick, large with dry frothy bubbles. There is white or grey coating and tough, stringy saliva. Taste is salty or soapy.

Discharges: Discharges and secretions are stringy, tenacious, salty and soapy, white or colourless.

All discharges are white, albuminous, stringy, sticky, copious, thick - 2nd stage of inflammation.

Yellowish, greenish, stringy, sticky, offensive, putrid - 3rd stage of inflammation.

*Kali-bich* - yellowish, lumpy, stringy; can be drawn into rope.

*Kali-carb* - thin, watery.

*Kali-iod* - yellowish, lumpy.

*Kali-mur* - grayish white.

**7. DEPTH OF ACTION:** *Kali* salts are chiefly indicated in organic diseases where functional changes have gone to pathological level.

**8. PH REACTION:** All the *Kali* salts are used for alkaline or basic tissues and their secretions, e.g., blood, saliva, CSF, intestinal juices, etc.

**9. THERMAL MODALITY:** *Kali* salts are chilly (except *Kali-bich* which is hot), but sensitive to heat of sun, summer.

**10. SENSITIVITY AND SUSCEPTIBILITY (REACTIVITY):**

(i)  $K^+$  is highly reactive and it does not exist free in nature. (ii) It reacts rapidly (aggravate) with water and decompose it and with cold as well as warm moist air.

It is hygroscopic (absorbs water) and it shows hydrogenoid constitutional properties. It is aggravated during April to July (in north continent), warm damp weather. Metabolism is affected by both hypoxia (anaerobic) as well as hyperventilation (aerobic) and its deficiency produces acidosis in fluid areas or increases more acidity in the fluids or secretions.

It is most powerful reducing agent and least oxidising agent. It reacts with tissues or secretions having excess or increased carbon dioxide, oxygen, hydrogen, sulphur and chlorine. Its action is mediated through water.

It shows immediate response to external stimuli.  $K$  shows cellular response.

**11. REVERSIBLE OR IRREVERSIBLE CHANGES:**  $K^+$  actively participates in the reaction. The reactions are mediated through water and they are ionic and reversible.

**12. ELECTRO-MAGNETIC FORCES:**  $K^+$  shows diamagnetic (repulsion) properties. It is aggravated by electromagnetic forces, x-rays, radiation, lunar rays, gravitational forces, water vapour, steam, fumes, gases, new moon, etc.

**13. MODALITIES:** Aggravation: After midnight 1-5 a.m, early morning.

*Kali-ars* < 1 am.

*Kali-carb* < 2-4 am.

*Kali-bich* < 2-3 am.

*Kali-sulph* & *Kali-iod* < 5.0 a.m.

< Emotional excitement, cold air, cold bathing, cold weather, getting wet; before, during and after menses, rich food, coition, touch, exertion.

Amelioration: Warm, slow movement, pressure.

**14. FOOD HABITS:** Aversion: Bread, coffee, food, water, meat, smoking. Aggravated by rich food, fat, milk, cold drinks, cold food, cabbage.

Desire: Beer, bread, cold drinks, sour, acid, sweet.



**15. MIND (*Kalium*):** During health, *Kali* persons are emotionally and intellectually balanced. They have clear perceiving, thinking and discrimination power. Their memory and understandings are good. Their conscience and intention are clear. They have sense of duty. They have strong principles, rules and norms and they abide by them. They are confident in their judgement. They are intelligent and calculating personality and have good motivation. They motivate accordingly to fulfil their task and give good performance. They achieve whatever they desire, through hard work and perseverance. They are highly respected in the society. They are scholars, artists and professionals, having high ambitions and expectations. They have strong attachment to loved ones, parents, children, society, workers, colleagues, wealth, wife, etc. They are conservative and control their emotions. They are materialistic, optimistic but not melancholic.

**DISEASE:** Conflict arises between emotion and intellect. Breaking off an attachment affects the person both emotionally and intellectually, so he must have immediately another attachment to become calm and quiet. Conflict and dissatisfaction shakes his conscience and all the problems arise. It affects thinking, perception, memory, will, discrimination and formulations and ultimately the action and behavior is affected. He has dual mental state i.e.

**Mood disorder or Affective disorder.**

**State a)** Excitement and anxiety.

In the excitement and anxiety state he is frightened. The fear and fright manifest in the dreams and delusions. He has fear of death, fear of evil, fear that something will happen, fear of insanity, fear of people, etc. He is discontented and discouraged in life. Feeling of insecurity and anticipatory anxiety develops **psychosomatic diseases**. He becomes suspicious, quarrelsome, self centered and reserved.

**State b).** Imbecile and forgetful.

He is imbecile and becomes absent minded. There is gradual loss of memory. His perception and discrimination power decreases. Concentration is difficult for

him and has confusion of mind that leads to hurried and wrong decision and he becomes more disappointed. He has various types of illusion. Illusions of ecstasy. Clairvoyance.

Thinking of complaints aggravates. He loses his self-confidence and becomes forgetful. Continuity of thoughts is disturbed with sudden vacant look. He becomes indecisive.

He makes mistakes in speaking, uses wrong words in writing. He does not want to answer or do any mental work. Mental fatigue. No perversion of sex.

In other phase he gets easily excited from contradiction. He becomes irritable, angry and restless without any appreciable cause or on slight trifles. Irritability and excitement remains for a short while. Physical ailments or psychosomatic diseases develop after vexation. They are irascible & quarrelsome. The violence develops after rage and fury. He repents and weeps when alone. Both the states cause disturbance in mood and affective disorder develops. His mind becomes dull, he does not want to talk: he has persistent thoughts, he does not want to meet people. He gets nightmares, talks in sleep and startles easily. Somnambulism. Homesickness, inclination to sit, and involve himself in religious activity. Religious mania. He feels guilty with repeated thoughts of suicide.

Insanity or madness, indifference to pleasure, loathing of life, aggravated from mental exertion, unconsciousness, and delirium. Nymphomania. Mental symptoms from sexual abuse.

**16. REMEDY RELATIONSHIP:**

Complementary: *Lithium* and *Natrum*.

*Kali* is inimical to *Lithium* and *Natrum*.

*Natrum* and *Kali* are agonistic and antagonistic to each other.

Notes: i. For the action of higher atomic number elements, lower atomic number elements are necessary, for example, for K: Na, Li.

ii. Never use *Kali* salts in dynamic potency when there is fever or severe pain.

