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# Nutritional Significance of Milk Minerals

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**_Abstract_**

*Mineral constituents occurs in milk and dairy products in the form of organic ions and salts; however, several minerals are also found associated with major milk constituents like fat, protein, carbohydrate and nucleic acid. Milk contributes significantly to the human dietary requirements of several minerals including calcium, magnesium, potassium, zinc, and phosphorus. Milk also contains some other minerals like chloride, selenium, etc. in relatively less but significant amount. Numerous factors, including species, breed, feeding, lactation stage, climate, handling after milking, shipping, and processing, have an impact on the mineral content of milk. Importantly, the bioavailability of many minerals is considerably high in comparison to other food sources, mainly owing to absence of anti-nutritional factors like oxalates and phytates. Minerals are considered essential nutrients, as they are not synthesized by human body, thus need to be obtained by diet. Milk minerals play crucial role in human health and overall development. They serve a variety of purposes in the body, and their deficiency in human body can cause both obvious and subtle symptoms. Adequate supply of calcium is necessary for proper development, strength, and density of bones in children. It is also required for prevention of bone loss and osteoporotic fractures in elderly people. Milk is also one of the most important sources of zinc, another vital mineral. Several research reports have highlighted the importance of adequate supply of zinc in growth and development, neurological function, immunological processes, reproductive health, etc. Milk is also a good carrier of selenium, which has recently been elucidated to have many roles in human health and disease prevention. Consumption of milk and milk products shall be encouraged in order to maintain and enhance overall health of the humans.*

**Keywords:** Milk, mineral constituents, nutrition, calcium, health

## INTRODUCTION

Milk is nutrient rich, chemically complex biological fluid which consist of hundreds of different constituents [1]. Milk is considered as “almost complete food”. Milk contains some principal nutrients like lactose (milk sugar), proteins, lipid, vitamins and salt that are modified to satisfy the particular developmental needs of developing neonatal [2–4]. As a major constituent, cow milk is mainly bovine milk is mostly made up of water (85–87%), lipids (3.8–5.5%), proteins (2.9–3.5%) as well as milk sugar (5%), but it also contains a variety of bioactive substances, such as vitamins, minerals, organic acids, nucleotides, oligosaccharides and immunoglobulins, at varying levels [4].

## MINERALS

Minerals are the inorganic substance that is needed by the human body for normal functions of different organs of human body [5]. They are required in very less amount, hence known as micronutrients. All minerals needed for human health are crucial nutrients because the body cannot synthesize them from other substances. Thus, we need to rely on the foods to fulfil the requirement of these important constituents [6].

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## CLASSIFICATION OF MILK MINERALS

Essential minerals are classified based on the minimum level required by human body (Table 1).

### Composition of Milk Minerals

Cattle milk has a salt level of 0.7 to 0.8%, although the amounts of the various ions might range significantly on an independent basis. Breast milk has a very low ash level (less than 0.2%), yet cow's milk has a higher concentration of all major and several minor ions than does mother's milk. Level of various minerals in milk in different species has been depicted in the Table 2 and RDA values of some of the minerals are depicted in the Table 3.

Minerals impart about 4 to 6% of body weight and in that about 50% as calcium and 25% as phosphorus (phosphates), the remainder being made up of the other essential minerals that must be derived from the diet [28]. Pie chart depicts the RDA value of minerals (Figure 1).

**Table 1.** Classification of milk minerals [7].

| Particulars | Major minerals | Minor minerals |
|---|---|---|
| RDA | >100 mg/day | ≤15 mg/day |
| Elements | Calcium | Zinc |
| | Magnesium | Copper |
| | Phosphorus | Iodine |
| | Sodium | Selenium |
| | Potassium | Lead |
| | Chloride | Boron |
| | Sulphur | Iron |
| | | Manganese |

**Table 2.** Level of various minerals in milk [1, 5–32].

| Constituents | Cow milk (mg/l) | Buffalo milk (mg/l) | Human milk (mg/l) |
|---|---|---|---|
| Sodium | 500 | 550 | 110 |
| Potassium | 1350 | Z1200 | 650 |
| Calcium | 1200 | 1800 | 320 |
| Magnesium | 120 | 200 | 30 |
| Phosphorus | 950 | 950 | 80 |
| Chloride | 1000 | 650 | 220 |
| Zinc (µg/l) | 3.5 | 5.1 | 2.9 |
| Selenium (µg/l) | 5–67 | 15–45 | 8–19 |

**Table 3.** RDA values of some of the minerals (mg/day) [15].

| Element | Men | Women | Pregnant and lactating |
|---|---|---|---|
| Calcium | 600 | 600 | 1200 |
| Magnesium | 310 | 310 | |
| Sodium | 2100 | 1900 | |
| Chloride | 1800 | 1800 | 2300 |
| Potassium | 3750 | 3225 | |
| Phosphorous | 600 | 600 | 1200 |
| Zinc | 12 | 10 | 12 |
| Selenium | 40 µg | 40 µg | |

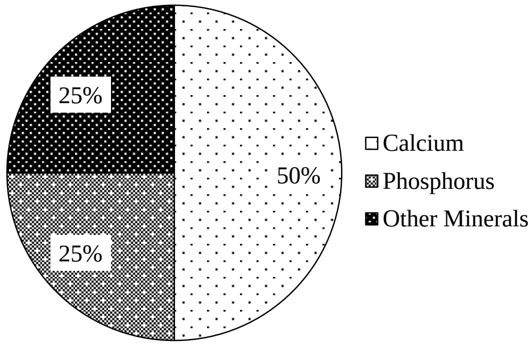


**Figure 1.** RDA value of minerals.

## NUTRITIONAL SIGNIFICANCE

Minerals are immensely significant from human health point of view. For example calcium has role in not only healthy bone structure, but in many metabolic reactions. Nutritional significance of such minerals is briefly described below.

### Calcium

Calcium is one of the most identifiable and vital elements. 1.5% of total body weight is constituted by calcium (Figure 1). Additionally, it guards the living organism from osteoporosis. It exists as a +2 charged ($Ca^{2+}$) atom in meals as well as the organism. For Indians, milk accounts for more than 55% of daily dietary calcium intake [11]. Bioavailability of calcium through milk is approximately 40 to 45% [19].

#### *Factors Affecting Calcium Absorption*

Oxalates and phytate are constituents of plant, which hold the calcium in the body and decrease the uptake of calcium by intestine. Ratio of P to Ca also determines the calcium absorption and it should not exceed 2:1. Phosphopeptides of bovine caseins may be involved in increasing calcium absorption by chelating the calcium to prevent precipitation [11].

#### *Calcium Homeostasis*

When normal blood calcium level decreases, the parathyroid glands secret a parathyroid hormone (PTH) [23]. It enhances the transformation of the inactive calciferol to its active form known as calcitriol. When level of blood calcium increases, PTH secretion reduces, ultimately hindering the conversion of calciferol to calcitriol in the kidneys [7].

#### *Role of Calcium in Bone and Teeth*

Major function of calcium is to make the bones and teeth rigid. There are two main complexes of calcium namely calcium phosphate [$Ca_3(PO_4)_2$] and hydroxyapatite [$Ca_{10}(PO_4)_6OH_2$]. Hydroxyapatite crystals is more rigid than calcium phosphate. This strong structure of hydroxyapatite makes teeth and bones more rigid. Structure of calcium phosphate is somewhat different than that of hydroxyapatite, it is softer than hydroxyapatite, this complex provides sufficient calcium and phosphate to maintain calcium and phosphate in blood. In adults, if diet lacks calcium, then it causes osteopenia. This condition leads to slight bone loss. But when bone loss is more, the condition created is known as osteoporosis [16]. Supplementation of Ca and calciferol together for 1.5–3 years led to significant decrease in hindquarters-fracture prevalence in old age women (mean age 84 years) [33].

#### *Role of Calcium in the Heart and Skeletal Muscle*

Calcium is also involved in regulation of nervous system. When our heart is beating, a specific cell in area of heart known as sinoatrial node generates an electrical impulse continuously. The remainder of the heart is then stimulated to contract by this impulse. The skeleton accumulates calcium at a rate of 150 mg on average per day, until the early 20s in humans. The skeleton is essentially in a state of Ca equilibrium during adulthood. All skeletal sites lose bone as bone balance turns negative at the age of

 

**Table 4.** Effect of calcium on lipid profile [12].

| Particulars | Low calcium | High calcium |
|---|---|---|
| Sterol (Chole) (mmol/l) | 5.99±0.65 | 5.66±0.57 |
| Triacylglycerol (mmol/l) | 1.74±0.81 | 1.89±0.92 |
| LDL (mmol/l) | 4.13±0.58 | 3.67±0.48 |
| HDL (mmol/l) | 1.06±0.22 | 1.11±0.32 |

about 50 years for men and the menopause for women [33]. Gaucheron [9] revealed that reduced Ca consumption in populations where hypertension is more prevalent, Ca has a positive relationship with lowering of blood pressure [12]. Table 4 depicts the effect of calcium on lipid profile.

***Role of Calcium in Nerves and Hormone***

The body's cells can interact among one another through neurotransmitters and hormones. For normal function of body, these hormones should release at appropriate time from particular glands. Basically, calcium takes part in the secretion of several of biological compounds from particular gland. Sometimes calcium can serve as a mediator or intermediate factor, as hormones trigger various physiological events. Scientists sometimes refer to this function as the "second messenger", when the hormone itself served as the first messenger [7].

***Role of Calcium in Blood Clotting***

Blood clumping components are triggered when a bleeding happens, as well as a clot eventually forms at the haemorrhage point. There are numerous phases involved in the clotting mechanism, some of which involve calcium. The clotting factors bind to calcium and become more active as a result [21].

***Osteoporosis***

Most studies link greater calcium dosage with better bone density, as calcium is one of the components of bone [16]. Two crucial elements in the prevention of osteoporosis are enhancing peak bone density accretion as well as reducing loss of bone after reaching the peak [22].

***Gastrointestinal Disease***

The chance of colorectal cancer was decreased by 5% with a daily rise in calcium intake of 100 mg, by 37% with a daily increase in calcium intake of 1,000 mg and 50% reduction in colon cancer with a daily increase in calcium intake of 1,000 mg [16]. Dietary calcium >1000 mg/d reduced chances of colon cancer by 46% and the chance of colorectal cancer by 30% [8].

***Kidney Disease***

Calcium phosphate and calcium oxalate play a role in the partial formation of kidney stone, which are a prevalent ailment of the renal stream. Calcium supplementation or high dietary calcium intake (>500 mg/d) may lower urine oxalate levels and hence reduce the risk of kidney stone development. Oxalate absorption is reduced by dietary calcium, which is likely related to when it is ingested in relation to how much oxalate is consumed. Urinary calcium levels above 300 mg/day for men, 250 mg/day for women, or 4 mg/kg/day for either gender in hypercalcemic on a random diet raise the possibility that urinary calcium may play a significant pathogenetic role in the formation of kidney stones and decreased bone density.

**Phosphorous**

Phosphate ($PO_4$) is the most recognizable form of phosphorus [34]. Phosphorus is the second most plentiful mineral in our body after calcium. Interaction of calcium and phosphate makes the bone and teeth rigid due to opposite charges. About 800 g of P is found in the human body, of which, 85% are linked to calcium in the bones and teeth. The remaining 15% is found in various forms, including phosphate of sugar, phospholipids in cell membranes and phosphoproteins [9]. $(HPO_4)_2^-$ or $H_2PO_4^-$, is the most inner cellular anion, similar to chloride in the outer cellular fluid [17].

 

***Regulation of Blood Phosphorus Levels***

Both diffusion pathways as well as vitamin D active transit are effective ways for the uptake of phosphorus in the small intestine. The level of phosphorus is regulated by calcitriol. If the blood phosphorus level is increased, then the secretion of PTH becomes less active and it excretes more phosphorus to urine by kidney and reduces the bone resorption. If blood phosphorus level decreases to a certain limit, then PTH secretion becomes more active and it resorps the phosphorus from bones and increases the level of blood phosphorus [35].

***Role of Phosphorus in Bones and Teeth***

The role of phosphorus is same as that of calcium, it forms mainly two complexes with calcium namely calcium hydroxyapatite [$Ca_{10}(PO_4)_6OH_2$] as well as calcium phosphate [$Ca_3(PO_4)_2$]. The role of hydroxyapatite is to make the teeth and bones hard and calcium phosphate maintains the level of phosphorus in intracellular fluid [16]. Elevated phosphorus and reduced calcium meals result in complexes that lower serum calcium levels and stimulate parathyroid hormone (PTH), which then triggers bone resorption and brings serum calcium levels back to normal. Bone deterioration in mammals has been linked to excessive dietary phosphorus levels [36].

***Energy System***

As it is well established that the energy generated from various nutrients is held in chemical linkages by specific compounds like ATP that contain phosphate (adenosine triphosphate). Guanosine-5'-triphosphate (GTP) and ATP are utilised to fuel cell functions.

***Significance of Dietary Phosphorus in Hypertension***

Inverse relation exists between phosphorus intake and blood pressure [37]. According to research, hyperphosphatemia raises the incidence of cardiac disease by substantially impacting endothelial function, soft tissue calcification, and vascular smooth muscle cells, which are strongly linked to arterial illness [38]. Only phosphorus found in milk products was linked to reduced blood pressure as well as a reduced chance of developing hypertension. Dietary phosphorus may raise serum phosphorus levels, which may therefore be linked to reduce blood pressure [37].

**Magnesium**

Multiple physiological systems depend heavily on magnesium ($Mg^{2+}$). It serves as a cofactor for more than 300 enzymes necessary for the relaxation of muscles, the secretion of neurotransmitters, as well as the control of ion channels [39].

***Role in Blood Pressure***

Cardiac and vascular smooth muscle are directly affected by level of magnesium. Certain evidences suggest that magnesium may regulate blood pressure because it encourages vascular smooth-muscle relaxation [12].

***Role As Enzyme Cofactor***

Anion charge neutralization is primary function of $Mg^{2+}$ in mammalian cells. Particularly, $Mg^{2+}$ is associated with nucleotide triphosphates and nucleotide diphosphates. Along with other highly anionic species, $Mg^{2+}$ is also present in multisubstituted sugar phosphates such nucleic acids (RNA as well as DNA), inositol triphosphate and certain carboxylates. This arrangement enhances the binding of the nucleotide phosphate to the enzymes that utilise them as substrates by neutralising the negative charge density on ATP or other nucleotide triphosphates or diphosphates [40].

***Magnesium and Osteoporosis***

Bones are composed of 60% of total body magnesium content, of which, 30% is skeletal magnesium. It is possible to swap the Mg on the exterior of the bones with serum magnesium [41]. The liberation of the residual skeletal magnesium, which is an important component of the bones, is reliant on bone resorption. Bone mineral density in both men and women is directly regulated by consumption of magnesium. Low serum magnesium has been shown to be linked with low bone density in pre- and postmenopausal women [42].

***Cardiovascular Health***

Maintaining a healthy level of magnesium in the body has many positive impacts, including improved endothelial activity, beneficial effects on arrhythmias, reduction of platelet activation, reduction of blood pressure, inflammatory reactions and platelet aggregation, induction of direct and indirect vasodilation, potential development in exercise tolerance in patients with stable coronary artery disease, and more [43].

***Diabetes***

A high $Mg^{2+}$ intake is linked to a lower incidence of type 2 diabetes. Lower $Mg^{2+}$ content of the diet is linked with a rise in risk for type 2 diabetes and the metabolic syndrome. Per 100 mg/day increase in dietary $Mg^{2+}$, the chance of developing diabetes is lowered by 14% [38].

**Potassium**

Potassium is the most occurring intracellular cation in human body [7]. Atoms of potassium, like those of sodium, are most at ease when they give up an electron as well as reside as $K^+$. Potassium is one of the important electrolytes in human body fluid, which is concentrated inside the cell fluids while sodium is primarily found exterior the cell.

***Role of Potassium in Human Body***

Absorption of potassium mainly occurs in small intestine. Kidney maintains the concentration of potassium in body. However, 98% of the potassium in intracellular, unlike sodium (and chloride). As a result, potassium plays a crucial role in the body's excitable cells' ability to conduct electricity [44]. The level of potassium is mainly controlled by the hormone aldosterone. When blood potassium concentration is decreased to some limit, hormone aldosterone is secreted from the kidney and it excretes more potassium into urine. This process causes the level of sodium and chloride to increase and decrease the blood potassium level [7].

***Regulation of Blood Pressure***

Reduction in systolic blood pressure (SBP) of 2–3 mmHg has been shown with increase in ingestion of 30 to 45 mmol potassium. In studies on potassium supplementation, a rise in regular potassium intake of 53 mmol was found to lower BP in hypertensive as well as normotensive subjects by 4.4/2.5 and 1.8/1.0 mmHg, respectively, as determined by 24-h urine potassium excretion [14]. One crucial factor that must be considered when analysing the connection between potassium consumption as well as blood pressure is the relationship between salt and potassium. Low sodium as well as high potassium diet have a synergistic impact on blood pressure [14].

***Cardiovascular Disease***

According to studies, a high potassium consumption is associated negatively with cardiovascular disease. Other dietary factors, as well as other recognised cardiovascular risk factors such as blood pressure, fasting blood glucose level, blood cholesterol level, age, obesity and smoking, were not associated with this connection [31].

***Kidney Disease***

High potassium intake prevents the growth of renal vascular, glomerular, and tubular damage without affecting blood pressure [14]. Numerous case studies in humans indicate a connection between chronic hypokalaemia and renal abnormalities. The question of whether increasing potassium consumption has any beneficial effects on the renal arteriolar, tubular lesions or glomerular that develop in either hypertension as well as kidney disease, however, has not been investigated in controlled trials [45].

***Potassium and Bone Health***

Even in the presence of high sodium intake, potassium alkaline salts, such as bicarbonate of potassium, are involved in to lower urine calcium excretion in healthy populations. It has been suggested that potassium may work through a number of different methods to stop sodium from causing calciuria and an accelerated rate of bone resorption. Additionally, potassium appears to have an immediate impact on the kidney to encourage calcium reabsorption.

**Sodium**

Sodium in different food present in form of $Na^{+}$. It became stable when it gives one electron. Sodium is the most recognizable electrolyte in extracellular fluid of the body. Manufacturers or the consumers add the sodium to food to enhance taste or for preservation purpose.

***Functions of Sodium***

More than 95% of the ingested sodium is absorbed by small intestine. So, the concentration of sodium is mainly maintained through urinary loss. Sodium is involved in three main functions: it is necessary for healthy muscle and nerve function, aids in water balance, and aids in the absorption of certain amino acids and glucose [46].

***Blood Sodium Level Regulation***

Hyponatremia is a condition in which a blood sodium level gets reduced. When blood sodium level is reduced, it stimulates adrenal gland releasing aldosterone. Aldosterone retains more sodium in blood and it also reduces the sodium loss in urine. Low blood pressure also increases aldosterone release from the adrenal glands by stimulating the kidneys to produce an enzyme called renin. Renin, together with angiotensinogen, Angiotensin I and Angiotensin II are involved in maintaining normal [7].

***Role of Sodium in Hypertension***

Dietary sodium minimization lowers blood pressure and the prevalence of hypertension as well as the risk of morbidity and mortality from cardiovascular illnesses [13]. In both hypertensive and normotensive adults, regardless of gender or ethnicity, a sustained minor reduction in salt intake resulted in a significant drop in blood pressure, with higher drops in systolic blood pressure accompanying larger salt reductions [12].

***Cardiovascular Risk***

The data showing a direct link between excessive sodium consumption and hypertension as well as a link between high sodium intake and an elevated risk of cardiovascular disease and mortality has been accumulated throughout time [13]. It is difficult to reduce salt intake for a long term as salt intake is regulated by brain mechanisms and associated homoeostatic systems.

***Significance of Sodium in Bone Health***

Because increasing dietary salt causes an increase in urine calcium excretion, dietary sodium has been viewed as possibly harmful. Cashman proposed that in healthy people, there is a roughly 1 mmol loss of renal calcium for every 100 mmol of salt lost in urine [47]. To put this calcium loss in the context of bone health, if intestinal calcium absorption did not improve to make up for it, a net calcium deficit of just 1 $mmol.day^{-1}$ would cause the typical adult skeleton to lose one-third of its calcium content in just over two decades [23]. So, it is always desirable to consume food which is high in calcium and low in sodium.

**Chloride**

One of the main minerals that our systems require in significantly higher amounts for good health is chloride. Although chloride can be found naturally in many foods, it is most frequently consumed as sodium chloride, also known as table salt. The ion name for chlorine is chloride. An atom called chlorine is most at ease when it steals an electron from another atom and has a negative charge (Cl). Chloride is a crucial electrolyte that is frequently overlooked in favour of sodium and potassium.

***Significance of Chloride in Human Body***

Chloride serves as an electrolyte in a manner similar to that of sodium and potassium. Actually, the majority of negatively charged electrolytes in human extracellular fluid, including blood, are chlorides. Chloride is crucial for the body's ability to eliminate carbon dioxide. Chloride channels play a crucial role in regulating how much water, what kinds of chemicals, and what nutrients enter and exit cells. Overall, they are crucial for maintaining the pH and fluid balance in our systems, which helps to control blood pressure. In addition, chloride is essential for the contraction of the heart and muscles as well as for the transmission of nerve impulses by our nerve cells from the brain to the body. Additionally, chloride aids in the production and release of hydrochloric acid (HCl), which is necessary for the proper breakdown and absorption of food in the stomach [48].

**Zinc**

Zinc is most recognizable trace element for normal growth of human body. Specifically, bones (30%) and muscles (60%) contain this element [9]. In the activity of greater than 200 enzymes and hormones, zinc takes part. It takes part in the production of proteins, the activation of DNA as well as RNA polymerases, the breakdown of fatty acids as well as the production of prostaglandins. Peptide hormones like thymulin and insulin have their structural integrity stabilised by it. Zinc is regarded as an antioxidant as well.

***Role of Zinc in the Body***

Zn acts as cofactor for several enzymes like superoxode dismutase for antioxidant protection [49], carbonic anhydrase for pH, alcohol dehydrogenase for alcohol metabolism, alkaline phosphatase for bone mineralization [24], carboxypeptidases for protein digestion, polymerases for protein and nucleic acid metabolism [50].

***Zinc Deficiency and Toxicity***

Zinc deficiency results in poor development in children, undesirable bone growth mineralization, late sexual maturity, reduce immunity and poor wound healing. Supplementation of zinc, especially by affluent class may result in zinc toxicity [18].

***Role in Atherosclerosis***

Atherosclerosis is a pathological condition marked by the development of atherosclerotic plaques in the vascular intima of large and medium-sized arteries [30]. The main factor causing cardiovascular diseases (CVDs), such as peripheral arterial disease, stroke, and coronary artery disease (CAD) are known as atherosclerosis. Zinc directly contributes to atherosclerosis through its interactions with atherogenic cells such endothelial cells (ECs), vascular smooth muscle cells (VSMCs) as well as immunological cells.

***Role of Zinc in Lipid Metabolism***

The relationship between zinc and fatty tissue is crucial for lipid breakdown. Zinc may control lipid metabolism by preventing leptin from being produced. The zinc/MTF1/PPAR as well as calcium/calmodulin-dependent protein kinase (CaMKK)/adenosine 5′-monophosphate act protein kinase pathways are activated by zinc, according to the study, and this leads to autophagy-mediated lipophagy [30]. An important part of lipid metabolism is played by zinc alpha 2-glycoprotein (ZAG), an adipokine that reduces fatty acid production, mobilises lipids, and promotes lipolysis. Supplementing with zinc has the potential to drastically lower plasma levels of triglycerides and very low-density lipoprotein (VLDL).

***Glucose Metabolism***

In the control of glucose metabolism and the release of insulin, zinc plays a crucial role. Low levels of zinc were linked to decreased insulin production from pancreatic beta-cells [26]. Zinc is thought to influence insulin's actions through a variety of methods. In addition to the indirect control of glucose metabolism by insulin modulation, zinc also directly affects glucose metabolism [30].

 

***Significance in Blood Pressure***

Zinc controls BP using a variety of ways. First, through affecting free radicle stress, Cu/Zn SOD performs a crucial role in controlling hypertension [30]. Activity of Cu/Zn-SOD is hindered in both cases like in higher and lower Zn intake [51]. Zinc may control the RAAS system, hence controlling blood pressure. The angiotensin-converting enzyme (ACE) needs zinc, a lack of which does reduces serum ACE activity.

***Role in Immune System***

Zinc is important element for immune responses. Although transferrin, $a_2$-macroglobulin, and albumin are the proteins that carry zinc to cells, it appears that only free Zn ions are physiologically active. Zinc modifies the $a_2$-macroglobulin's structural makeup and improves its interaction with cytokines and proteases, which indirectly affects immune activity [52]. Innate immunity suffers when there is a zinc shortage.

***Zinc and Cardiovascular Diseases***

Endothelial cells quickly absorb zinc ions, probably through endocytosis of albumin-bound zinc. Modifications in dietary zinc, especially deficits, have the ability to modify endothelial cell levels of zinc because the plasma protein-bound zinc pool is rapidly turning over and in rapid equilibrium with total plasma zinc. Diabetes, coronary artery disease, and a number of related risk factors for hypertension, including hypertriglyceridemia and insulin resistance, were all linked to lower serum zinc levels [52].

***Role in Cancer Prevention***

Numerous nutrients, including zinc, which is essential for host defence against the onset and spread of numerous cancers, have been implicated in cancer prevention. Studies have indicated that patients with cancer of the breast, gallbladder, lung, colon, head, and neck have lower serum zinc level [25].

***Zinc and Aging***

Deficiency of Zn and decreased bioavailability of Zn causes altered neuroendocrine function and an increase in apoptosis which leads to decline in immune function [20]. A chronic stress-like state throughout ageing causes intracellular Zn to be sequestered, which leads to poor Zn ion bioavailability for immunological function as well as the activity of Zn-dependent enzymes and proteins [52].

***Zinc and Diabetes Mellitus***

Diabetes mellitus (DM), a metabolic disease, is characterised by an increase in blood sugar levels and a disturbance in glucose metabolism, either as a result of decreased insulin secretion or as a result of diminished sensitivity of the body's cells to insulin [1–29, 53]. Zinc and insulin have a physical and chemical connection. Since two zinc ions are located on the centre of each insulin hexameric unit, zinc binding to insulin is crucial for the hormone to crystallise [53].

***Zinc and Bone Formation***

The strength of animal or human bone or skeletal is mainly impacted by this trace element. Through a variety of routes, Zn has a significant bone-protective impact at physiological doses. It stimulates growth by igniting the enzymes necessary for DNA, RNA and protein synthesis, which boosts osteoblast activity and encourages collagen formation. Additionally, Zn can prevent osteoclastic bone resorption [53].

**Selenium**

Earlier this element was considered as toxic element. Selenium concentration in human body is 10–15 mg [54]. Selenium helps with growth, promotes good muscular function, supports the reproductive system, lessens the toxicity of some substances like mercury, strengthens the immune system and slows the spread of some viruses (influenza, Ebola, HIV) [54]. Selenium's importance for human health was not realised until 1979, when Chinese researchers discovered that selenium helped prevent a heart problem in kids and teenagers living in Keshan province. Since then, there has been a rapid advancement in the understanding of scientists regarding the function of selenium in the Keshan disease and other areas of human health [9]. For 25–30 genetically distinct enzymes to function, selenium (Se) is absolutely necessary (selenoenzymes) [54].

***Selenium is Incorporated into Selenoproteins***

Selenium has a high bioavailability in food and is not subject to any controls during intestinal absorption. Selenium is taken up by cells, transformed into selenomethionine, and then used to make proteins after being absorbed and circulated. Selenoproteins are proteins that contain selenomethionine. Selenium can be introduced into other proteins through selenium metabolism and selenoprotein degradation. Through the use of selenomethionine and selenoproteins, the body is able to maintain a sizeable amount of selenium in muscles. Elevating or lowering the amount expelled in urine allows for the maintenance of blood levels of selenium. When intake is high, selenium can also leave the body through the breath and give off a garlicky stench [7].

***Selenium is an Important Antioxidant***

The body contains at least 14 selenoproteins. Glutathione peroxidases are a class of enzyme selenoproteins with redox properties that guard against oxidative degradation. For thyroid function and for the metabolism of vitamin C, more selenoproteins are required. Researchers are particularly interested in how crucial selenium may be for the immune system and how it can work to prevent cancer because it has such a wide range of protective characteristics [7].

***Selenium Deficiency and Toxicity***

Keshan illness occurs when deficiency of selenium is severe. The soil in Keshan region contains extremely little selenium. Keshan illness, primarily affects children and can be fatal leading to major heart issues [7]. A mild selenium deficiency can reduce antioxidant protection and impair the effective action of thyroid hormones. Meanwhile, Keshan disease's root cause has been identified as severe selenium deficiency. Over time, selenium intakes above 750 µg/day can result in toxic changes such nausea, hair as well as nail loss, exhaustion, and vomiting as well as a disruption of appropriate protein synthesis.

***Health Effects of Selenium***

*Antioxidant Protection*

As a component of the glutathione peroxidase enzyme, selenium aids in preventing cell damage brought on by free radicals. Free radicals like hydrogen peroxide and other organic peroxides are rendered inactive by glutathione peroxidase. Being a water-soluble molecule, glutathione peroxidase's antioxidant actions often occur in the watery part of cells rather than in and around cell membranes like vitamin E. It is understood that, selenium and vitamin E work together to protect cells from oxidative damage.

***Activity of Thyroid Hormone***

Deiodinase, an enzyme involved in the metabolism of iodide, also appears to include selenium. Scientists are working to better understand this function of selenium, which is yet not fully understood. It appears that in some organs, this selenium-containing enzyme aids in the transformation of thyroid hormone from its less active form, thyroxine (T4), to its more active form, triiodothyronine (T3).

***Effects on the Brain***

The brain needs selenium to function properly; selenium insufficiency results in irreversible brain damage whereas selenium depletion preserves brain selenium at the expense of other tissues. Selenioprotein P delivers selenium directly to the brain due to its affinity for the lipoprotein receptor apoER2 [3].

***Cardiovascular Disease***

Evidence showing selenoproteins decreasing platelet aggregation, prevents oxidative alteration of lipids, and reduces inflammation, backs up selenium's potential cardiovascular benefits. Studies have found substantial inverse relationship between low selenium consumption or status as well as the risk of coronary heart disease [27].

### *Cancer*

A possible protective effect of selenium on the risk of bladder, oesophageal, lung, thyroid, colorectal, liver, gastric-cardia and prostate cancer has been suggested by prospective studies [27]. Selenium has been repeatedly linked to a lower chance of developing low-grade or localised prostate cancer, and the highest protective connections have been found in smokers [10].

## CONCLUSION

Minerals are the important constituents of milk, which are involved in normal body functioning. Milk is acknowledged as good source for several of these minerals. The contribution of milk to RDA of minerals is higher as compared to other foods. Milk does not contain any antinutrient, consequently bioavailability and absorption of minerals through milk is relatively high. Minerals are vital nutritional component. Their deficiency leads to several diseases including osteoporosis, hypertension, neurological diseases, kidney diseases, cancer, heart diseases etc. Combination of different foods and relative timing of consumption of different foods affect the absorption of some minerals like calcium. The minerals of the milk are important class of nutrient defining completeness of milk and milk products. Consumption of milk and milk products shall be encouraged in order to maintain and enhance overall health of the human population.

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