

Effects of Sugar, Salt and Distilled Water on White Blood Cells and Platelet Cells

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ABSTRACT

In this review article, we have dug to our best of knowledge a detail and depth view about white blood cells (WBCs) and platelet cells, their types, disorders. The effects of three analytes (glucose, salt and distilled water) have been studied that how their reactivity and concentration changes in healthy and cancerous person.

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Key words: Immune system; Coagulant factor; Invaders; Phagocytic action; Oxidative stress; Inflammation; Glycation

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INTRODUCTION

Blood in our body which plays a vital role not only in transportation of oxygen but also minerals, salt, water and food ingredient in the form of energy to all parts of body through blood vessels^[1]. Blood is majorly composed of plasma (55%) and blood cells (45%). In this review, we will only focus on blood cells, which are of two types (i) white blood cells (leucocytes) and (ii) platelet cells (thrombocytes). These cells are structurally and functionally different from each other^[2](Figure 1).

The purpose of investigation of WBCs and platelet cells was because they manage two important systems of body. Immune system (the system which captures and kills the germs and protects the body from diseases) is run by WBCs^[3] and coagulant system (blood clotting system during injury or cut) is run by platelet cells^[4].

We have summarized the effects of three analytes i.e. glucose, salt and distilled water on the reactivity of WBCs and platelet cells. Many methods, techniques and instruments are used to analyze the effects of these three analytes like optical coherence tomography (OCT), computed tomography (CT), magnetic resonance imaging (MRI), photo acoustic spectroscopy (PAS), light polarimetry, Raman spectroscopy, mid infrared spectroscopy (MIS), optical diffuse reflectance (ODR) and microscopy etc^[5-8].

WHITE BLOOD CELLS

White blood cells are also called leucocytes. They are found through the whole body either in blood or lymphatic system. These are produced in bone marrow and form immune system. Hence, WBCs not only protect body from invaders (germs which enter into the body) but also from different diseases^[3]. WBCs perform Phagocytic action (the process in which WBCs engulf the bacteria and died)^[9]. They are responsible to make quick action against parasitic infection, central nervous system diseases, allergic and antigen response etc. Increasing no of WBCs in blood indicates disease. These contribute

approximately 1% of whole blood^[10]. Blood contains 4,000 to 11,000 white blood cells per micro liter. These are the cells which have lowest contribution in blood. If no of WBCs increase above 11,000 the condition is known as leucocytosis and below 4,000 is known as leucopenia. All the WBCs contain nucleus. The life time of WBCs is normally from 13 to 20 days. The production of WBCs increases when body gets either injury or diseased^[11]. One of the most important types of WBCs is neutrophil which constitute 60-70% of WBCs. They live only 4-5 days. They protect the body from germs like bacteria and fungi through phagocytic action as shown in figure 2.

Types of leukocytes

There are two main types of WBCs; lymphocytes and myeloid leucocytes. However, myeloid are further classified into four types. So, as a whole there are five types of WBCs; neutrophils, eosinophils, basophils, lymphocytes and monocytes. These all perform different function. They have different shapes^[12-13].

Disorders of WBCs

There are two types of disorders in WBCs. These are leucopenias and proliferative. If the number of WBCs increases from the normal value is known as proliferative disorders and if number of WBCs decreases from the normal value is known as leucopenias^[14].

Leukopenia Disorders: The disorder in which number of WBCs is less than normal value is called leucopenias. Usually two types of Leucopenia are observed which are neutropenias and lymphocytopenias^[15]. **(a) Neutropenia:** the disorder in which number of neutrophil cells is less than normal value is called neutropenia. This disorder is either due to less production or excess removal of neutropenias from blood^[15]. So this disorder is either intrinsic or extrinsic^[16]. The causes of neutropenia are radiations, serious infection, immune or blood dysfunctions, medicines like quinine, antibiotics, drugs and alcohols etc^[17]. **(b) Lymphocytopenia:** if the number of lymphocytes is less than normal value then the disorder is known as lymphocytopenia. This is also internal or external i.e. either less production of lymphocytes or excess removal (death) of lymphocytes. The causes of lymphocytopenia are listed as inherited, serious surgery, radiations, viral diseases, transplantation of body parts like kidney^[14].

Proliferative Disorders: If the number of WBCs is greater than the normal value then the disorder is known as proliferative disorders. These types of disorders are seen mostly in neutrophils and eosinophils cells which are known as neutrophilia and eosinophilia^[15]. **(a) Neutrophilia:** if number of neutrophil cells increases in blood from normal value is known as neutrophilia^[14]. This disorder is either caused by excess production of cells in blood or by disease. These types of disorders are caused by the factors like cigarette smoking, inherited, infection, cancer, medicines, diseases like ulcer, tuberculosis hepatitis and surgery^[18]. **(b) Eosinophilia:** when number of eosinophil cells is higher than $0.65 \times 10^9/L$, the disorder is known as Eosinophilia. The no of these cells vary at day and night time. It also varies in new born baby and an adult. The factors of this type of disorders are still not known and are under process^[16].

THE ANALYTES (GLUCOSE, SALTS AND PURE WATER) IN NORMAL LEUKOCYTES

Effect of glucose

Glucose is a carbohydrate whose level in blood changes throughout the day. Though, it is very vital source of energy for body but its abnormal use disturbs the proper functioning of not only blood but

also other vital organs^[18-19]. Normal glucose level without having meal is between 70 and 99 mg/dL and after 2 hours taking meal is less than 140 mg/dL^[20]. If blood contains more glucose than normal value is called hyperglycemia and if less than normal value is known as hypoglycemia^[21]. When glucose level fluctuates in blood from its normal value then not only RBCs but also WBCs and Platelet cells are affected. It is noted that the effect of sweets remains for 2-5 hours after you eat it. Sugar has direct and severe effects on immune system i.e. on WBCs. By drinking 1 Liter bottle of soda or by eating 100 gram sugar, the reactivity of WBCs reduces 40%. This can make our immune system disable for 4 or 5 hours. WBCs perform the function of immune by killing bacteria and virus through phagocytosis. Vitamin C is very vital for proper functioning of WBCs. Sugar and vitamin C has the same chemical structure. When we eat sugar it directly competes with vitamin C as a result less vitamin C enters into WBCs. Sugar does not help WBCs to fight against pathogens and hence weakens their reactivity shown in figure 3. So, high

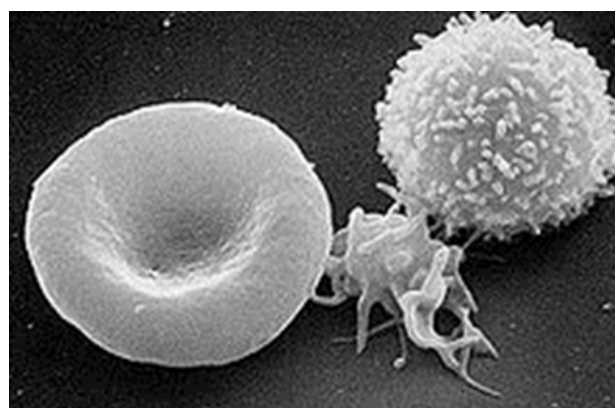


Figure 1 Scanning electron micrograph (SEM) of RBC, Platelet cell and WBC from left to right (reprinted with permission)^[2].

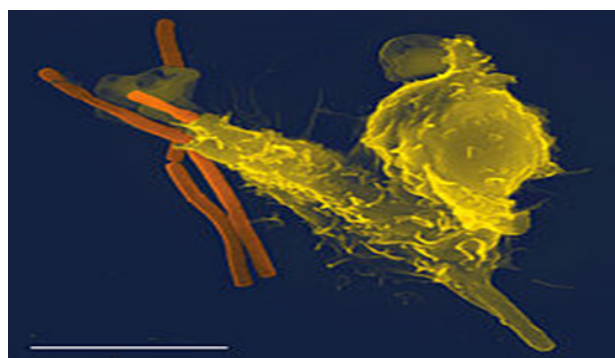


Figure 2 Neutrophil engulfing bacteria (reprinted with permissions)^[49].

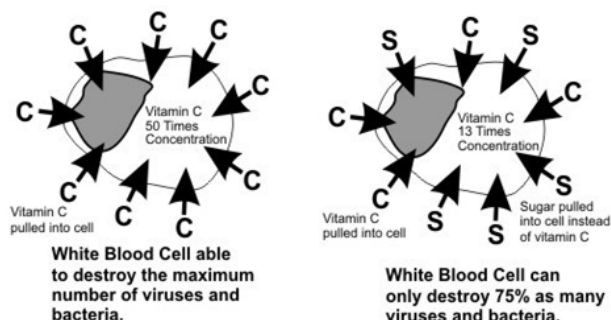


Figure 3 Less reactivity of WBCs with increasing glucose concentration (reprinted with permission)^[22].

glucose level in blood weakens the immune system by decreasing WBCs reactivity. In order to maintain the normal reactivity of WBCs we should take fresh fruits and vegetables^[22].

Effect of salt

Salt is another important ingredient of diet to maintain homeostasis in body. Normal value of sodium is between 135-145 mmol/L^[23]. If concentration of sodium is less than normal value, the condition is known as hyponatremia^[24-25], and high concentration condition is termed as hypernatremia^[26]. Hypernatremia usually results in high blood pressure. Effects of salt can more clearly be seen on WBCs than RBCs because they are nucleated and have sensitive membrane. If the concentration of sodium is increased in blood then water moves out of blood vessels causes dehydration and less sodium intake water moves into the blood. These variations cause renal disorders^[26]. Now, the effects of hypernatremia on WBCs occurs in such a way; it increases the production of immune cells which causes the autoimmune diseases like diabetes type-1 and sclerosis (hardening of tissues). During hypernatremia, the immune system becomes less responsive due to over production of immune helper T cells which attack healthy tissues by producing protein interleukin. This condition is known as autoimmunity. Hence high intake of sodium produces high immune cells like helper T cells which attack healthy tissues by producing protein interleukin^[27-28].

Effect of distilled water

WBCs have membrane which is permeable and water can move outside and inside of the cell through special protein channels depending upon the concentration of water. Depending upon concentrations of solutes the movement of water is of three types, isotonic solutions, hypertonic solutions and hypotonic solutions. In hypotonic solution the concentration of water inside the cell is less than outside of cell, then water will move from outside to inside and cell bursts. In hypertonic solution the concentration of water is higher inside the cell than outside of the cell, then water will move from inside to outside of the cell hence cell will shrink. In isotonic solution the concentration of water inside and outside of cell is same so, cell neither shrinks nor bursts^[29].

PLATELET CELLS

These are also known as thrombocytes, and are the smallest cells present in blood^[4]. One microliter of blood contains 150,000 to 400,000 Platelets^[30]. They are without nucleus and are pieces of cytoplasm^[4]. These are found in mammals only and in non mammals are mononuclear cells. They look like dark purple spots concave shape when blood is examined under microscope, but they are like plates so are called Platelet cells^[31].

Disorders of Platelet Cells: If the no of Platelet cells is either greater or less than normal value, there exists disorder. There are two main types of disorders of platelet cells (i) thrombocytosis (ii) thrombocytopenia. Now, we shall discuss the disorders individually, their conditions and causes.

Thrombocytosis

If the no of platelet cells is greater than the normal value then the disorder is known as thrombocytosis. There are two cases for thrombocytosis either primary or secondary. In case of primary thrombocytosis the no of platelet cells are increased by bone marrow, while in case of secondary thrombocytosis the increase in platelet cells is due to infection or disease like anemia, cancer and

inflammation etc. Following is the series of causes of thrombocytosis, blood clotting in legs or arms, infection, diseases like anemia cancer etc^[32-34].

Thrombocytopenia

If no of Platelet cells are less than normal value then the disorder is known as thrombocytopenia. This disorder is due to excessive bleeding from different parts of body like nose. The causes which prevent the body to form platelet cells are medicines, inheritance, drugs and alcohol, kidney diseases, chemotherapy of cancer^[35].

Effect of glucose on Platelets

Glucose is a carbohydrate which is composed of carbon, hydrogen and oxygen. Its concentration changes with food and age wise. If its level increases from normal value known as hyperglycemia or diabetes and lower concentration is known as hypoglycemia. There are three types of diabetes: type 1, type 2 and gestational diabetes. Type 1 is the diabetes which is due to less production of insulin by pancreas, which may be genetic and mostly occurred in people having age less than 20 years. Type 2 is the diabetes which is also known as life style diabetes. This is due to overweight in adults because they do not perform activities. About 90% diabetes is type 2. The third type of diabetes which occurs in women during pregnancy and contributes only 4% of all types of diabetes. This is temporary and is removed after baby born. In type 2 diabetes, the reactivity of Platelet cells is increased due to deficiency and resistance of insulin by increasing glycation (the process of making covalent bond of protein with sugar) of platelet proteins. Oxidative stress (imbalance between the re-action of oxygen with biological system to repair the damage) and inflammation (the response of body tissues against pathogens) are the causes of diabetes, which results dysfunction of endothelial (inner lining of blood vessels) and increases platelet reactivity by less production of Nitric Oxide (NO). Inflammation and platelet activity are reciprocal to each other i.e. inflammation increases the platelet activity that in turn increases inflammation. Hence platelet reactivity is increased in diabetes associated with the factors like metabolic abnormalities, insulin deficiency and resistance, oxidative stress, inflammation and endothelial dysfunction^[36]. In case of metabolic abnormalities where sugar level increases (hyperglycemia) and lipid level increases (hypertriglyceridemia) the reactivity of platelet increases by glycation and osmotic effect. Deficiency and resistance to insulin, result diabetes and hence increases platelet cells reactivity. Oxidative stress and inflammation may also cause diabetes and results increased platelet reactivity by reduced production of Nitric Oxide (NO), excess release of calcium from platelet cells and dysfunction of endothelial. Hence in diabetes platelet reactivity is increased by the factors given above^[37-38].

Effect of salt on platelets

Salt is another important ingredient of blood, whose level in blood is increased by extra intake of salt or diet defects. There are two disorders for salt concentration, higher concentration than normal value is hypernatremia^[26] and lower concentration than normal value is known as hyponatremia^[24-25]. Hypernatremia results many complications due to high blood pressure. When sodium is accumulated in blood vessels then blood pressure is increased and causes many problems like, cardiovascular system, dehydration, increases mass of left ventricle, increases renal function, increases no of strokes and increases the stiffness and resistance activities of arteries etc^[26]. The mechanism of increased platelet reactivity during high salt intake is due to accumulation of Sodium (Na)^[39-40].

Due to high sodium intake aggregation (clumping of cells together) of platelet cells increases. High intake of salt effects Adrenaline (hormone produced by adrenal glands) which acts on membranes of platelet cells and results the platelet aggregation. Hence, intake salt concentration affects not only other systems but also changes reactivity of platelet cells^[41-42].

Effect of distilled water on Platelets

Water is important ingredient of diet which maintains homeostasis (to maintain balance or internal stability of different ingredient). When concentration of dissolved solutes changes either inside or outside of cell then concentration of water also changes from inside or outside respectively. There are three types of solutions in which the reaction of platelet cells can be seen. These solutions are isotonic, hypertonic and hypotonic solutions. The movement of water inside and outside of the cell is through the process of diffusion (the process in which water molecules moves from an area of higher concentration to lower concentration through semi-permeable membrane). These cells show same attitude under three conditions as WBCs^[29].

FOR CANCEROUS PERSON

Cancer is a group of disease which is due to abnormal growth of cells that have the tendency to move from one body part to others^[40]. These abnormal cells make a group by uncontrolled cell division and form a lump which is called tumor or neoplasms. Cancer is either caused by environmental factors (90-95%) or inherited genetics (5-10%). Out of environmental facts that causes cancer death contribute tobacco 25-30%, diet 30-35%, infections 15-20% (caused by virus, bacteria and parasite), radiations 10%, pollution, lack of physical activity and stress etc^[43-45].

Effect of sugar on cancerous WBCs

It is well known that tumor cells use more sugar than normal cells^[46]. Granulated sugar or simple carbohydrate is directly linked with tumor cells. Tumor cells can easily metabolize simple carbohydrates but not fats. Once cancer cells grew up in the body they need steady supply of sugar for energy. In another meanings high fructose corn syrup (HFCS) causes cancer by a special mechanism, mercury in HFCS makes bond with selenium. Selenium level is decreased. So, high insulin is needed to control sugar level in blood. This high insulin promotes cancer. In women this causes breast cancer by producing more estrogen which has insulin receptors both speed up cell division. In this way, high insulin causes breast cancer^[47]. Tumor cells use both sugar and fructose as their food. Pancreatic cancer uses both of these to help tumors. Sugar and vitamin C has the same chemical structure. When we eat sugar it directly competes with vitamin C as a result less vitamin C enters into WBCs. Sugar does not help WBCs to fight against pathogens and hence weakens their reactivity^[19].

Effect of salt on cancerous WBCs

Salt is an electrolyte whose varying concentration in blood is the cause of complication like dehydration, neurological and cancer etc. Hypernatremia is the condition in which sodium serum concentration is greater than normal value. It is caused by excessive loss of water through skin or urine^[48]. Hyponatremia is the condition in which serum sodium concentration is less than normal value is called hyponatremia. It is caused by excessive water intake, dysfunction of kidneys to excrete excessive water and drugs. Hyponatremia in case of tumor is more dangerous than hypernatremia. It has different ranges depending upon sodium concentration like Mild hyponatremia

<135, moderate <132, severe <130 and life threatening <125 mmol/L. During hyponatremia, action of WBCs reduces dangerously with the decrease of sodium level. Nausea and malaise are caused below 125-130 mEq/L. Headache, lethargy and obtundation and eventually seizures, coma and respiratory arrest are caused below 115-120 mEq/L^[51]. During hypernatremia the immune system becomes less responsive due to over production of immune helper T cells which attack healthy tissues by producing protein interleukin. This condition is known as autoimmunity. Hence high intake of sodium produces high immune cells like helper T cells which attack healthy tissues by producing protein interleukin^[27-28].

SUMMARY

We have reviewed the effects of three analytes (sugar, salt and distilled water) on WBCs, platelets and cancerous counterparts. We reveal that these analytes changes the reactivity of WBCs, platelets for both normal and abnormal cases. WBCs protect the body from pathogens by phagocytosis. Under high glucose intake immune cells reactivity reduces due to less vitamin C entrance into cells. High intake of sodium causes autoimmune diseases by producing more helper T cells which damages living tissues. Under abnormal usage of water cell either shrinks (hypertonic) or bursts (hypotonic). Platelet cells are very vital cells of blood and their function is to stop bleeding in case of any injury and in healing wounds by hemostatic plug formation. Under the effect of three analytes (glucose, salt and water) the reactivity of platelet cells increases when sugar increases due to deficiency and resistance of insulin by the process of oxidative stress, glycation and inflammation. During high salt and less Ca intake platelet cells reactivity decreases and less salt and high Ca intake may increases platelet reactivity. Water also effects reactivity of cells by shrinking (hypertonic solution) which results no cell division and swelling (hypotonic solution) which results damage of cell. Cancer cells can easily synthesize carbohydrates for their growth and nourishment. They use glucose and fructose as their food. Thus, sugar promotes cancer and weakens the immune system. Hyponatremia is more dangerous than hypernatremia to weaken the immune system. Sever hyponatremia even leads to death. Under the condition of three solutions of water, WBCs shrink (hypertonic solution), burst (hypotonic solution) or not affected (isotonic solution).

CONFLICT OF INTERESTS

There are no conflicts of interest with regard to the present study.

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