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Qualitative Analysis of How Certain Plant Products Can Increase the Rate of Blood Coagulation in Humans

Aatish Sunder
Department of Science
San Mateo High School
San Mateo, USA

Arpit Chopra
Department of Science
India International School in Japan
Tokyo, Japan

Connor Dam
Department of Science
San Mateo High School
San Mateo, USA

Abstract:- Blood Coagulation is an essential process that occurs in the human body. Coagulation or clotting is the process in which blood forms lumps/clots to help prevent excess loss of blood. Coagulation consists of three main stages which are the injury phase, vascular spasm/platelet formation, and coagulation. This process is first started by an injury, which can vary from a paper cut to a knee scrape. The vascular spasm/platelet formation is the second stage, when the platelets come together around the broken collagen to cause a chemical reaction. During the final or coagulation phase, there are a cascade of reactions that change the structure of blood from a colloid into a gel that maintains blood hemostasis by preventing the loss of blood. The reactions are triggered by certain chemicals, some of which are found in natural products, which increase the rate of blood coagulation. The purpose of this analysis was to examine the ways through which the rate of blood coagulation could be increased by using the chemicals from plant products such as Vitamin K found in kale and spinach and Potassium found in bananas, experimented on blood samples under observed conditions.

Keywords:- *Blood Coagulation; Vitamin K and Potassium, Spinach, Kale and Bananas.*

I. INTRODUCTION

"Blood coagulation, [or clotting], is [the body's] host defense system that aids in maintaining the integrity of the closed, high pressure, mammalian circulatory system after blood vessel injury" [1]. Clotting works at a specific rate and requires a cascade of catalysts to start the clotting process. Simplified, blood clotting occurs when Fibrinogen is converted to Fibrin by the thrombin protein. The clot minimizes blood loss from the wound by impeding the blood flow from the injured blood vessel. Our blood tends to clot in minor events like cuts, but also severe traumatic injuries like a scraped knee. The basic steps of clotting are categorized into 3, injury, vascular spasm, and coagulation. This can happen in the extrinsic pathway (trauma) or the intrinsic pathway (small injury). First, the injury process is usually triggered by damage to the epidermis which then goes to the next part of blood clotting which is the vascular spasm. A vascular spasm is when the muscles, specifically the smooth muscles, contract. This causes there to be a decrease in blood loss. When you get injured, broken collagen or the protein that consists of your connective tissue is able to contact platelets, which are components of blood in charge of the clotting process. During this time, the smooth muscle in the broken blood vessel contracts to lower the loss of blood. Then the platelets release cytokines, VEGF, serotonin, and many more factors to contact other platelets to help them move in units and cover the broken collagen. Once this happens, the coagulation cascade occurs. A protein called thromboplastin along with calcium ions is released by the platelets and is converted to prothrombin. Prothrombin is then easily converted into thrombin. And thrombin acts as a coenzyme and helps the conversion of fibrinogen, which is another important clotting factor, to fibrin. Fibrin helps create a clot to trap erythrocytes from escaping. [1]. A question was raised on how to raise the rate of blood coagulation by using plant-based products. Under certain circumstances, it is possible to increase the rate of blood coagulation through intensive pressure, for example, with the use of bandages; however, usually, this method tends to work for minor injuries and cuts and takes some time to stop the bleeding. So, the idea was to implement the use of natural products to accelerate the process of blood coagulation. Natural Products are chemicals that are secreted from plants which can be used for many purposes, especially medicine. The next step was to pick the plants useful for our study. Kale and Spinach were viable options because of their excess calcium and vitamin K contents, and bananas since they contain potassium, an electrolyte that has the property to coagulate colloidal solutions.

II. MECHANISM OF COAGULATION

➢ *Intrinsic Vs Extrinsic Pathway (Inside Vs Outside And Minimal Injury Vs Trauma):*

The intrinsic pathway is activated when there is trauma inside the circulatory system. "[Blood coagulation] begins with the activation of Factor XII which becomes Factor XIIA after exposure to endothelial collagen" [5], which happens after the endothelial cells are damaged. A cascade then occurs with factors being catalyzed and catalyzing other reactions. Factor XIIA catalyzes the reaction of Factor XI to Factor XIA. Factor XIA catalyzes Factor IX to Factor IXA. Factor IXA catalyzes the reaction of Factor VIII to Factor VIIIA. Finally, Factor VIIIA catalyzes the reaction of Factor X to Factor Xa. The extrinsic pathway is activated by the same process. Endothelial cells release tissue factor, which catalyzes the reaction of Factor VII to Factor VIIA. Factor VIIA catalyzes the reaction of Factor X to Factor Xa. This is where the 2 pathways become one, the common pathway. Factor Xa along with a cofactor, Factor V, catalyzes prothrombin into thrombin. Thrombin then catalyzes the reaction of fibrinogen to fibrin. Thrombin activates other intrinsic pathway factors. Fibrin subunits for fibrin strands, with Factor XIII, form a fibrin mesh, which helps stabilize platelets.

➢ *Role Of Calcium Ions In The Conversion Of Thromboplastin To Prothrombin*

Calcium ions play a vital role in many of the reactions in blood coagulation. Thromboplastin is the enzyme that catalyzes the reaction prothrombin to thrombin. Calcium ions are a cofactor for that enzyme, allowing the reaction to be catalyzed. Thrombin is then used to catalyze the reaction of fibrinogen. "Fibrinogen is an essential coagulation protein produced by the liver (MW340 kDa) and is the precursor of fibrin that ultimately defines the strength of the clot." [2]. Fibrinogen is then converted to its final form of fibrin. Fibrin is a protein that helps trap the erythrocytes and form the final clot.

➢ *Platelets And Their Formation from Megakaryocytes*

Platelets (thrombocytes) are a blood component that reacts to bleeding by clumping, forming a blood clot. They are fragments of cytoplasm which are derived from megakaryocytes, which are found in the bone marrow. Platelet production is regulated by thrombopoietin, which signals the production of platelets.

➢ *Importance Of Vitamin K In the Clotting Factors and Those Involved in the Antihemophilic Action*

Vitamin K is an essential cofactor for carboxylase which catalyzes the carboxylation of glutamic acid on vitamin K-dependent proteins. By doing this, they allow the protein to bind to membrane surfaces and allow the formation of specific proteins. The important vitamin K-dependent proteins are factors II (prothrombin), VII, IX, and X. They allow for the process of coagulation to occur. Without vitamin K, coagulation would be impaired, causing you to bleed out [6]. Vitamin K also is a cofactor of anticoagulation proteins C, S, and Z. These prevent too much coagulation from occurring, which could cause clots, preventing the blood flow. Vitamin K undergoes a cycle that can allow it to be reused. Vitamin K is first reduced to vitamin KH2. When vitamin KH2 is oxygenated, it drives a carboxylation reaction, forming carboxyglutamic acid residues and vitamin K oxide. It is then reduced by another reductase back to vitamin K. Anticoagulants block the reduction of vitamin K, which explains how they reduce clotting.

➢ *Coagulation of Colloids by Electrolytes*

Coagulation of colloids, such as blood, often takes place through the addition of electrolytes as a difference in charges is introduced. Colloidal particles interact with the ions of the opposite charges rather than that of themselves, resulting in neutralization of the colloidal solution, resulting in coagulation of the colloid [3].

III. SPINACH AND KALE

Spinach is a green leafy flowering plant. Kale is a form of cabbage that is closely related to wild varieties. Spinach is composed of 91% water, 4% carbohydrates, 3% protein, with trace amounts of fat. Kale on the other hand is composed of 84% water, 9% carbohydrates, 4% protein, and 1% fat. Both foods have high amounts of vitamin A, vitamin C, vitamin K, folate, and Manganese. Vitamin K is particularly important for our paper, which both crops contain around 4 times over the recommended daily dose, (483 and 418 µg per serving). Both also contain high amounts of calcium (99 mg and 72 mg per serving). Spinach specifically has high amounts of iron, 2.71 mg. However, raw spinach contains oxalates, which prevent the absorption of calcium and iron in the body. Uncooked kale contains large amounts of polyphenols, oxalic acid, and glucosinolate compounds [4].

IV. METHOD AND MATERIALS

➢ *Method of conducting the experiment*

1. Measure 5 g of kale, spinach, and a banana each and bring into a fine paste and transfer each into different tubes.
2. Measure 15 ml of milk and put it in each of the three tubes, and mix thoroughly.
3. Using a blood sugar tester, make a piercing on your finger allowing the blood to drip. Place a drop of blood for each solution on a test slide (3 solutions and 1 negative control require 4 drops of blood).
4. Place a drop of solution for each drop of blood, respectively, not adding any external solution to the negative control.
5. Mix the solution and drop of blood, using a small toothpick or the end of a syringe, in circular motion to ensure the solution and drop of blood are well combined.
6. Wait for at least 5 minutes to notice the formation of clots or the change in the appearance of the solutions.
7. Observe any changes and note down the qualitative data, until the blood has coagulated or dried.

➢ *Materials:*

❖ 3 test tubes
❖ Mortar and pestle/blender
❖ Microscope slide
❖ Blood Sugar Tester/Sterile pin
❖ Dropper

➢ *Concentration of Solutions*:

❖ 5 g of kale (10 mcg of vitamin K) and 15 ml of 3.7% fat milk.
❖ 5 g of spinach (3 mcg of vitamin K) with 15 ml of 3.7% fat milk
❖ 5 g of banana (18 mg of K+ concentration) mixed with 15 ml of 3.7% fat milk

V. OBSERVATIONS

The given table describes the changes in the blood samples after a period of thirty minutes and the quality of the blood samples obtained in the end.

TABLE I.

	Blood Coagulation in Solutions			
	Spinach	***Kale***	***Banana***	***Negative control (blood)***
Initial Observations (5-10 minutes after starting the experiment)	The last solution to coagulate, almost within eight minutes, evident from the appearance of a dark lump in the center of the drop.	Coagulated the fastest, which was evident from the appearance of a dark red lump at the center of the drop. It was initially less viscous than the other solutions.	Coagulated fast (just after the kale solution) and formed smaller white lumps, within six minutes, with no formation of a dark red lump in the center.	It formed a small dark red lump in the start at the center and was viscous. Coagulating two minutes after the kale solution, but faster than the other solutions.
Viscosity	Formed a big purple lump and became highly viscous.	Towards the end, it became a highly viscous solution, however still slightly less than the others.	The whole part was viscous and resembled a gooey substance	Viscosity of the blood increased over the time observed and became highly viscous towards the end.
Final Observations (Color, Viscosity, Coagulated Surface)	An extremely dark clot appeared in the end of the experiment, black in color, and coagulation was seen in the entirety of the drop.	It was very discolored, and the dark red lump turned into a very dark shade, nearly black at the end of the experiment and the blood on the outer circumference of the drop completely dried up as well.	Even towards the end, no purple lump appeared, however, it was highly viscous. The whole drop combined in forming a giant lump in the end, despite no change in color	Only a dark red lump appeared, compared to the kale and spinach that formed purple lumps. Towards the end as well, it remained red, with a dark red lump, drying up around the outer circumference.

➢ *Results:*

All the solutions coagulated and dried faster than the negative control/blood. Kale solution coagulated the fastest, followed by spinach and then banana. The banana solution did not form a purple lump and coagulated as such. The rest of the solutions formed purple lumps in the center, drying up on the outer circumference of the drops.

VI. CONCLUSION

In the experiment, the rate of coagulation was measured with three different solutions that include spinach, kale, and banana. After mixing the solutions, apparent changes were seen within the blood composition and the formation of clots. The data stipulated supports the proposed hypothesis as well as the alternative hypothesis, as each of the solutions displayed a qualitative change. Kale, Spinach, and Banana's chemical composition as well as electrolytes contributed to increase the rate of coagulation and clot faster than the negative control. The hypothesis that certain plant products can increase the rate of blood coagulation is based on the experiment conducted and the results observed where kale, spinach, and bananas observed an increased rate of coagulation and clotting in the blood samples.

All the solutions appeared highly viscous and displayed the complete process of coagulation. However, there may have been possible errors that could have occurred and impacted the results causing variations: difference in the blood type, lack of sterile environment, improper light and sunlight, contaminated blood, and temperature all could have affected our experiment and the results yielding from it.

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