The Effect of Plasma Jet on Blood Components of Mice Infected With Diabetes

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Abstract. The diabetes can be induced by injecting "Alloxan" into animals. It shows a good response in animals specially in "mice, rabbits, mice, dog, and rats". The drug dosage is between "90 and 200mg/kg of the body weight". The "Alloxan" motivate" blood glucose" and the experimental animals shows response to the injected drug. The samples which are used in this study are mice male gender with age ranging between three and four months and weight (20-25)gm, these mice are injected with "Alloxan" with a dose of alloxan(200mg/kg) to study effect of alloxan on blood compounds (The cells of white blood, the cells of red blood and platelets) and study the effect of plasma jet on the infected mice for different time exposure, the component of blood shows different response to the plasma jet effect the White Blood Cells (WBC) and the Platelets(PLT) approach the normal case in the 30 second, the Red Blood Cells (RBC) , HGB the concentration of hemoglobin in whole blood and (HCT) the ratio of red blood cells to the volume of blood plasma approach the normal case in 50 second, the (MCV) mean cell volume approach the normal value in 10 second.

Keywords: Alloxan, Blood compounds, Cold plasma jet

1. Introduction

Alloxane is an organic compound, which is chemically known as 5,5-dihydroxy pyrimidine-2,4,6-trione [1]. The compound has the form C4H2N2O4, the mass of relative molecular, and molecular formulae is of 142.06 It is one of the popular agents of diabetes that is repetitively utilized in applications involving diabetes to evaluate the antidiabetic ability of both plant extracts and pure compounds [2]. Diabetes mellitus is a class of metabolic disorders where blood sugar levels are high over, and is one of the world's major chronic non-infectious diseases [3]. Many complications may result from the diabetes. Severe long-term risks contain stroke, cardiovascular disease, chronic kidney disease, the ulcers of foot, unhealthy lipid rates, damage to the blood vessels (vascular and microvascular), kidney-like organ damage, nerve damage and the damage of eye [4]. Diabetes may occur either because the body's cells that do not respond properly to the insulin released or the pancreas that does not produce enough insulin [5]. Diabetes mellitus is classified as a collection of metabolic diseases characterized by hyperglycemia output from insulin action, insulin secretion defects or both, or insulin resistance in the muscles of skeletal, liver and the tissues of adipose with β-cell compensation failure and a relative insulin deficiency [6].
1.1. Type of Diabetic and Causes
1-Insulin-dependent diabetes mellitus (IDDM, type 1) or type 1 diabetes,
2- Non-insulin-dependent diabetes mellitus (NIDDM, type 2) or type 2 diabetes,
3- Gestational diabetes is the third main type that happen when the women who are pregnant with no prior history of diabetes have elevated blood sugar levels, which is about 7% of all pregnancies diagnosed in the second or third trimester [7,8,9].

1.2. Plasma jet
Plasma mostly is an ionized gas which incorporates charged and neutral particles (electrons, ions, and molecules). Plasma has free charged particles where the positive and negative charges store each other roughly at the macroscopic stage [10,11]. Plasma has two kinds: the atmospheric plasma is thermal and non-thermal or cold. At the same temperature, thermal plasma has ionic, electrons and neutral particles. Cold atmospheric plasma (CAP) is a particular plasma form, which at the point of application is less than 104 ° F CAP processing methods for example Dielectric Barrier Discharge (DBD) [12,13] exist in many forms. plasma pencil, Plasma Jet and plasma pin for ambient pressure. Many different gases, for example Ar, N\textsubscript{2}, He, heliox (a combination of O\textsubscript{2} and He), and air can be used to create CAPs. There is growing interest in the use of plasma for biomedical applications, especially under the so-called 'plasma drug' to take advantage of the action of low-power, air-pressure plasmas for therapeutic purposes, for this researchers have paid attention to in seeking applications for cold plasma in medicine because of CAP 's ability to deactivate microorganisms, cause cell detachment and cause death in the cells of cancer [14,15]. In this work argon gas was used in the conventional atmospheric pressure jet plasma system to produce cold plasma to prepare the Blood.

1.3. Blood Components
Blood circulates through our bodies, providing vital substances for example nutrients and oxygen to the cells of the body. This also takes away metabolic waste products from the same cells [16]. The blood of human comprises four basic elements: the white blood cell, the red blood cell, and platelets. Figure 1 displays the elements of blood [17].

![Figure 1. The components of blood][15]

**The Red Blood Cells:** make up 40 per cent of your blood. They 're produced at a rate of 4x10\textsuperscript{6} to 4x10\textsuperscript{6} /hour from the bone marrow. They have a lifecycle in the body of around 4 months [18].

**Platelets**
Platelets are a formidable part of the blood. Platelets are the smallest part of the blood cells and in their non-active state they actually appear like tiny plates. Bleeding is controlled on platelets. [19]
Blood Plasma
Plasma is the blood part that is liquid. Plasma is yellowish in color and mainly consists of water but also includes proteins, salts, hormones and sugars [20].

The white Blood Cells
The white Blood Cells (leukocytes) are only around 1 per cent of your blood, but they are very big. The white blood cells are vital to good health and to protect against cancer. Unlike the red blood cells, the bone marrow is continually producing them. We circulate through the bloodstream and invade foreign bodies, for example viruses and bacteria. Moreover, they can go to the bloodstream in order to expand the struggle into tissue [20]. HGB, hemoglobin concentration in whole blood, MCV, mean volume of cells [16]. HCT the hematocrit reflects the relationship between red blood cells and blood plasma volume [16].

2. Experimental work
The animals which are used for analysis male gender BALB/c mice with age ranging from 3 to 4 months with weight (20-25) gm. they are divided into seven sets. The alloxan dose injected into mice is 200 mg /kg.

The groups which are used in the search are
G1= Control group
G2= Infected group injection with alloxan
G3= Infected group exposed to jet plasma 10 sec.
G4= Infected group exposed to jet plasma 20 sec
G5= Infected group exposed to jet plasma 30 sec.
G6= Infected group exposed to jet plasma 40 sec.
G7= Infected group exposed to jet plasma 50 sec.

Plasma jet System
Argon gas was used in the conventional atmospheric pressure jet plasma system to produce cold plasma to prepare the Blood, as shown in Figure 2. The plasma system consists of the following parts:

- High voltage power supply of 15kV, and 23kHz.
- A hollow metal tube made of stainless steel, 3cm in length and 1mm in diameter, which connects to the anode of the power supply.

The metal strip of conductive stainless steel, 6cm length, and 5mm width, which ends with a flat piece (1×1) that connects to the cathode of the power supply (cathode).

![Figure 2. Experimental set-up of plasma jet Technique.](image-url)
3. Results and discussion
For the diabetic infected mice sugar level is calculate by using the blood glucose monitoring system. The blood collected from mice and the full blood count CBC is then checked by (Roche cobra c11) in which the test is performed. Table 1 shows normal, infected and treated blood components for different time of exposure, Figure 3 shows the time response histogram for the contaminated jet plasma and the normal event. the value of blood test which are listed in Table 1 and Figure 2 shows there is a significant change between the normal, infected and that exposed to plasma jet the value of (WBC) increased for the infected case, the response of the WBC in the 30 second is the best among the others times in which WBC approximated from the normal value, (RBC), HGB and (HCT) will increase for the infected cases and approach the normal value with 50 second exposure the RBC and HGB will increased for the infected value and reach the normal value in the 50 second, the (PLT) decreased with infected case and approach the normal case in the 30 second and the (MCV) approach the normal value in 10 second, since the plasma is an ionized case it gives energy to blood cell and help them to reaper the problem which occur when inducing the debit in mice when injected with Alloxan.

| Table 1. the complete blood count (CBC) for normal, infected and treated with plasma. |
|-------------------------------|---------------|--------------|----------------|----------------|----------------|---------------|
| Test                          | normal        | infected     | Infected with diabetic and exposed to plasma | 10sec | 20sec | 30sec | 40sec | 50sec |
| WBC  /µL                      | 2.3×10³       | 7.8×10³     | 4.9×10³ | 4.6×10³ | 4.1×10³ | 5.6×10³ | 4.8×10³ |
| RBC  /µL                      | 7.26×10³      | 9.67×10³    | 10×10³ | 9.08×10³ | 5.57×10³ | 9.80×10³ | 6.50×10³ |
| HGB  g/dL                     | 10.5g/dL      | 13.9g/dL    | 14.2g/dL | 13/dL | 8.8g/dL | 14.3g/dL | 9.5g/dL |
| PLT  /µL                      | 1117×10³      | 979×10³     | 1609×10³ | 1000×10³ | 1009×10³ | 1319×10³ | 1814×10³ |
| MCV  fL                       | 51.5fL        | 58.7fL      | 52fL   | 49.8fL | 49.6fL | 55.2fL | 54fL |
| HCT  %                        | 37.4%         | 56.8%       | 52.2%  | 45.2%  | 27.6%  | 54.1%  | 35.1% |

![Graph of WBC and RBC over time](image-url)

- WBC: White Blood Cells
- RBC: Red Blood Cells
- HGB: Hemoglobin
- PLT: Platelets
- MCV: Mean Corpuscular Volume
- HCT: Hematocrit
Figure 3. The Blood Components for normal, infected and treated with plasma for different time.

4. Conclusion
It has been concluded that the components of blood show different response to the plasma jet that effect the White Blood Cells (WBC) and the Platelets (PLT) approach the normal case in the 30 second, the Red Blood Cells (RBC), HGB the concentration of hemoglobin in whole blood and (HCT) the ratio of red blood cells to the volume of blood plasma approach the normal case in 50 second, the (MCV) mean cell volume approach the normal value in 10 second.

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