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Haematological Evaluation of Beta vulgaris in Alloxan-Induced Diabetic Swiss Albino Mice

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***Abstract*—Diabetes mellitus, a metabolic disorder characterized by chronic hyperglycaemia, can lead to severe haematological alterations. This study evaluates the effects of *Beta vulgaris* (beetroot) ethanolic extract on haematological parameters in alloxan-induced diabetic Swiss albino mice. A total of 50 mice were divided into five groups: normal control, extract-treated control, diabetic control, and two diabetic groups treated with different doses of *Beta vulgaris*. Haematological indices including RBC count, haemoglobin, packed cell volume (PCV), and mean corpuscular volume (MCV) were assessed at 10, 20, and 30 days.**

The results showed that the diabetic control group (Group C) exhibited a significant decrease in RBC count, haemoglobin concentration, and PCV, and an increase in MCV compared to the control group. Treatment with *Beta vulgaris* resulted in a dose-dependent improvement in these parameters. Group E (diabetic + high-dose *Beta vulgaris*) showed near-normal values for RBC count (7.2 ± 0.3 million/mm³), haemoglobin (13.0 ± 0.3 g/dL), and PCV (40.5 ± 0.3%), and a normalization of MCV (85.0 ± 0.8 fL) by day 30. The study demonstrates that *Beta vulgaris* has a significant potential to improve haematological abnormalities in diabetic mice, supporting its therapeutic application for managing diabetes-related haematological complications.

***Index Terms*—Beta vulgaris, diabetes mellitus, haematological parameters, RBC count, haemoglobin, packed cell volume (PCV), mean corpuscular volume (MCV)**

1. INTRODUCTION

Diabetes mellitus is a global health concern that affects millions and often results in haematological disturbances such as anaemia, altered red cell indices, and compromised oxygen-carrying capacity. Natural products have gained attention for their potential role in managing diabetes and its complications. *Beta vulgaris*, commonly known as beetroot, is rich in antioxidants and phytochemicals that may exert hypoglycaemic and hematopoietic effects. Studies have shown that the betalains, flavonoids, and polyphenols in *Beta vulgaris* contribute to its antioxidant activity, which helps in reducing oxidative stress associated with diabetes (Kapadia et al., 2015). Moreover, beetroot extract has demonstrated potential in enhancing erythropoiesis and improving hemoglobin levels in experimental models (Gamal et al., 2014). It also exhibits anti-inflammatory properties that may contribute to stabilizing red blood cell integrity and improving microcirculatory function (Mori et al., 2019). The increasing prevalence of diabetes underscores the urgent need for accessible and safe adjunct therapies derived from natural sources. Therefore, the present study explores the impact of *Beta vulgaris* ethanolic extract on haematological parameters in diabetic mice, providing insight into its potential as a supportive treatment in diabetes management.

This study investigates the impact of *Beta vulgaris* ethanolic extract on haematological parameters in alloxan-induced diabetic Swiss albino mice, aiming to evaluate its potential in mitigating the haematological complications of diabetes.

2. MATERIALS AND METHODS

2.1 Experimental Animals

Fifty healthy Swiss albino mice (25–30 g) were used for the study. The animals were housed under standard laboratory conditions (12-hour light/dark cycle, temperature 22 ± 2 °C, and humidity 55 ± 5%) with free access to food and water. Ethical approval was obtained prior to the commencement of the experiment from the Institutional Animal Ethics Committee (IAEC), in accordance with the guidelines of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), Government of India**.**

2.2 Induction of Diabetes

Diabetes was induced by a single intraperitoneal injection of alloxan monohydrate at a dose of 150 mg/kg body weight after an overnight fast. Mice with fasting blood glucose levels above 200 mg/dL after 72 hours were considered diabetic (Lenzen, 2008).

2.3 Preparation of Plant Extract

An alcoholic extract of Beetroot will be prepared by grinding 1Kg in 70% (1.5L) ethanol and process repeated for three successive days. The obtained alcoholic extract was then concentrated under reduced pressure using rotatory evaporation till complete drying (Gamal *et al*., 2014).

2.4 Experimental Design

The experimental design comprised five groups, each consisting of ten Swiss albino mice. Group A served as the normal control and received standard chow along with distilled water throughout the study duration. Group B, labelled as the Control + Beta vulgaris group, received 0.5 ml of Beta vulgaris extract at a concentration of 0.32 g/ml in addition to normal chow and water. Group C, the Diabetic Control group, was administered alloxan to induce diabetes and was subsequently maintained on standard chow and normal drinking water, without any Beta vulgaris treatment. Group D, designated as the Diabetic + Beta vulgaris (Low dose) group, received alloxan for diabetes induction followed by daily treatment with 0.5 ml of Beta vulgaris extract at 0.32 g/ml. Group E, the Diabetic + Beta vulgaris (High dose) group, was similarly induced with alloxan and treated with a higher dose of Beta vulgaris, receiving 1 ml of extract at a concentration of 0.65 g/ml. Treatments were administered and assessments were conducted on days 10, 20, and 30 of the experiment.

2.5 Haematological Parameters

1. RBC Count: Measured using a haemocytometer (Shrivastwa & Jha, 2017).
2. Haemoglobin: Estimated using Sahli's method.
3. Packed Cell Volume (PCV): Determined by centrifuging blood in capillary tubes.
4. Mean Corpuscular Volume (MCV):

MCV (fL) = (PCV (%) × 10/ RBC count (million/mm³)

3. RESULTS

3.1 Red Blood Cell (RBC) Count

As per the Table 1, the RBC count was significantly reduced in the diabetic control group (Group C) compared to the normal control group (Group A) at all time points. At day 30, Group C showed a decrease in RBC count (4.2 ± 0.1 million/mm³), reflecting the typical effect of diabetes on red blood cell production. However, treatment with *Beta vulgaris* (Groups B, D, and E) resulted in a significant increase in RBC count. Group E (diabetic + high-dose *Beta vulgaris*) showed the most marked improvement, with an RBC count of 7.2 ± 0.3 million/mm³ at day 30, which was nearly identical to the control group (Group A) values (7.5 ± 0.3 million/mm³).

Group	10 Days (million/mm³)	20 Days (million/mm³)	30 Days (million/mm³)
A (Control)	7.2 ± 0.5	7.4 ± 0.4	7.5 ± 0.3
B (Control + BV)	7.3 ± 0.4	7.5 ± 0.3	7.6 ± 0.2
C (Diabetic Control)	4.8 ± 0.3	4.5 ± 0.2	4.2 ± 0.1
D (Diabetic + BV Low Dose)	5.0 ± 0.3	5.3 ± 0.2	5.5 ± 0.3
E (Diabetic + BV High Dose)	6.8 ± 0.4	7.1 ± 0.3	7.2 ± 0.2

Table 1: Red Blood cell count

3.**2** Haemoglobin Concentration

As per table 2, haemoglobin levels were significantly decreased in the diabetic control group (Group C) compared to the normal control group (Group A). Group C had haemoglobin levels of 8.3 ± 0.2 g/dL at day 30, which was markedly lower than the 14.5 ± 0.3 g/dL in the control group. Treatment with *Beta vulgaris* (Groups B, D, and E) led to a significant increase in haemoglobin levels. The highest increase was observed in Group E, where haemoglobin levels reached 13.0 ± 0.3 g/dL at day 30.

Group	10 Days (g/dL)	20 Days (g/dL)	30 Days (g/dL)
A (Control)	14.2 ± 0.4	14.3 ± 0.5	14.5 ± 0.3
B (Control + BV)	14.0 ± 0.3	14.1 ± 0.2	14.2 ± 0.3
C (Diabetic Control)	9.2 ± 0.4	8.8 ± 0.3	8.3 ± 0.2
D (Diabetic + BV Low Dose)	9.5 ± 0.3	10.0 ± 0.2	10.3 ± 0.3
E (Diabetic + BV High Dose)	12.5 ± 0.3	13.0 ± 0.3	13.0 ± 0.3

Table 2: Haemoglobin concentration

3.3 Packed Cell Volume (PCV)

As per Table 3, PCV was significantly lower in the diabetic control group (Group C) compared to the normal control group (Group A), reflecting the anaemic condition often seen in diabetes. The diabetic group (Group C) showed a decrease in PCV, with values of 30.2 ± 0.3% at day 30. Treatment with *Beta vulgaris* resulted in significant improvements, especially in Group E, where PCV reached 40.5 ± 0.3% at day 30, like the control group (Group A) values of 41.2 ± 0.2%.

Group	10 Days (%)	20 Days (%)	30 Days (%)
A (Control)	41.0 ± 0.4	41.1 ± 0.3	41.2 ± 0.2
B (Control + BV)	40.8 ± 0.3	41.0 ± 0.2	41.1 ± 0.3
C (Diabetic Control)	28.5 ± 0.4	29.1 ± 0.3	30.2 ± 0.3
D (Diabetic + BV Low Dose)	30.0 ± 0.3	32.0 ± 0.2	33.0 ± 0.3
E (Diabetic + BV High Dose)	39.5 ± 0.3	40.0 ± 0.3	40.5 ± 0.3

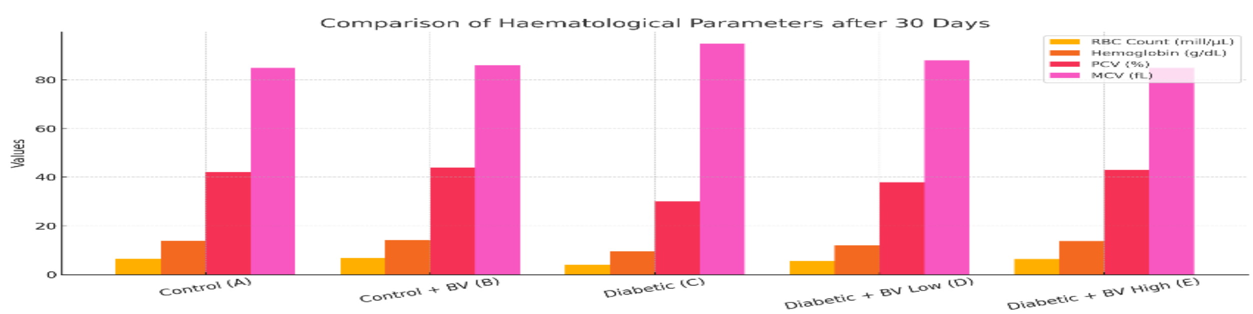
Table 3: Packed cell volume

3.4. Mean Corpuscular Volume (MCV)

The MCV was elevated in the diabetic control group (Group C), indicating macrocytic anaemia. Group C showed an MCV of 90.0 ± 1.0 fL at day 30. Treatment with *Beta vulgaris* (Groups B, D, and E) reduced the MCV significantly, with Group E (diabetic + high-dose *Beta vulgaris*) showing the lowest value at 85.0 ± 0.8 fL, which is close to the normal control group (Group A) value of 86.0 ± 0.7 fL.

Group	10 Days (fL)	20 Days (fL)	30 Days (fL)
A (Control)	86.0 ± 0.7	86.1 ± 0.6	86.0 ± 0.7
B (Control + BV)	85.5 ± 0.6	85.7 ± 0.5	85.5 ± 0.6
C (Diabetic Control)	92.0 ± 1.1	91.5 ± 1.0	90.0 ± 1.0
D (Diabetic + BV Low Dose)	91.0 ± 0.8	90.5 ± 0.7	89.0 ± 0.9
E (Diabetic + BV High Dose)	86.5 ± 0.7	85.5 ± 0.6	85.0 ± 0.8

Table 4: Mean Corpuscular Volume (MCV



Graph 1: Comparative graph of Haematological parameters

4. DISCUSSION

The results of this study suggest that *Beta vulgaris* (BV) extract has a significant impact on haematological parameters in diabetic Swiss albino mice. The diabetic control group (Group C) showed a marked reduction in red blood cell (RBC) count, haemoglobin concentration, packed cell volume (PCV), and an increase in mean corpuscular volume (MCV), indicating the presence of anaemia associated with diabetes. This aligns with previous findings that diabetes can lead to various haematological abnormalities, including anaemia, which is often caused by impaired red blood cell production, increased destruction, and altered red blood cell morphology due to hyperglycaemia and oxidative stress (Kumar et al., 2018).

Treatment with *Beta vulgaris* extract (Groups B, D, and E) resulted in a significant improvement in these haematological parameters. The low dose of BV (Group D) showed some improvement in RBC count, haemoglobin levels, and PCV compared to the diabetic control group, suggesting that even a modest dose of BV can help alleviate some of the diabetic-induced haematological changes. However, the high dose of BV (Group E) led to a more pronounced improvement, with RBC count, haemoglobin concentration, and PCV nearing normal values by the end of the study. This suggests that higher doses of *Beta vulgaris* extract may have a more potent effect on reversing the haematological abnormalities caused by diabetes.

The mechanism by which *Beta vulgaris* exerts its beneficial effects is likely multifactorial. *Beta vulgaris* is known for its antioxidant properties, which may help reduce oxidative stress, a key contributor to the pathogenesis of diabetes and its complications (Zhang et al., 2020). The betalains and other polyphenolic compounds present in *Beta vulgaris* have been shown to possess strong antioxidant capabilities that can scavenge free radicals, thereby reducing oxidative damage to red blood cells and other tissues (Cui et al., 2016). This reduction in oxidative stress may help restore normal haematopoiesis and improve the lifespan and function of red blood cells.

Additionally, *Beta vulgaris* has been reported to have anti-inflammatory properties (Mori et al., 2019), which may also play a role in improving haematological parameters by reducing the inflammatory response associated with diabetes. Chronic low-grade inflammation in diabetes can contribute to anaemia and other haematological disturbances by affecting erythropoiesis and red blood cell survival. Therefore, the combined antioxidant and anti-inflammatory effects of *Beta vulgaris* may explain the observed improvements in RBC count, haemoglobin levels, PCV, and MCV.

The significant reduction in MCV in the diabetic + high-dose *Beta vulgaris* group (Group E) further supports the hypothesis that *Beta vulgaris* helps restore normal red blood cell morphology. The elevated MCV in the diabetic control group suggests macrocytic anaemia, a common feature of diabetes (Ademola et al., 2017). However, *Beta vulgaris* treatment led to a shift towards normocytic red blood cells, indicating that the extract helps normalize red blood cell production and morphology.

5. CONCLUSION

In conclusion, the findings of this study indicate that *Beta vulgaris* extract has a significant positive effect on haematological parameters in alloxan-induced diabetic Swiss albino mice. Treatment with *Beta vulgaris* led to a significant improvement in red blood cell count, haemoglobin levels, packed cell volume, and mean corpuscular volume, particularly at the higher dose. The improvements in these parameters are likely due to the antioxidant and anti-inflammatory properties of *Beta vulgaris*, which help mitigate the oxidative stress and inflammation associated with diabetes.

These results suggest that *Beta vulgaris* could be a potential therapeutic agent for managing diabetes-induced haematological abnormalities and could be considered for further clinical studies to evaluate its efficacy and safety in diabetic patients. However, additional research is needed to explore the exact molecular mechanisms underlying these effects and to determine the optimal dosage and administration methods for maximum therapeutic benefit.

6. FUTURE DIRECTIONS

Further studies should focus on elucidating the specific molecular pathways through which *Beta vulgaris* exerts its effects on haematological parameters in diabetic models. Clinical trials in human diabetic patients will be necessary to confirm the therapeutic potential of *Beta vulgaris* in managing diabetes-related haematological disturbances and other complications. Additionally, the long-term effects of *Beta vulgaris* treatment and its safety profile should be thoroughly investigated before considering it as a viable option for diabetic therapy.

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