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*RESEARCH ARTICLE*

# THE EFFECT OF QUERCETIN ON SOME HEMATOLOGICAL PARAMETERS AGAINST BISPHENOL-A EXPOSURE IN STREPTOZOCIN-INDUCED RATS

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## ABSTRACT

Bisphenol-A (BPA) is an endocrine-disrupting environmental toxin widely used in the composition of plastics. Today, the widespread use of BPA in preserving and packaging food and beverages increases BPA exposure. Therefore, recent research has focused on the health effects of continuous exposure to BPA. This study aimed to investigate the protective effect of quercetin (QUE) on different hematologic variables in rats induced by the environmental toxin BPA and streptozocin (STZ). Wistar albino rats were administered BPA orally (p.o.) at 10 mg/kg and QUE intraperitoneally (i.p.) at 15 mg/kg for 14 days. STZ was administered subcutaneously (s.c.) in a single dose of 50 mg/kg at the beginning of the experiment. 72 rats were randomly selected for the experimental procedure and divided into 9 groups with 8 animals in each group. The groups were created as follows; Group 1: Control (Saline); Group 2: Corn oil (0.5 ml, solvent); Group 3: STZ (50 mg/kg); Group 4: BPA (10 mg/kg); Group 5: QUE (15mg/kg); Group 6: STZ (50 mg/kg) + QUE (15mg/kg); Group 7: BPA (10 mg/kg) + QUE (15mg/kg); Group 8: STZ (50 mg/kg) + BPA group (10 mg/kg); Group 9: STZ (50 mg/kg) + BPA (10 mg/kg) + QUE (15mg/kg). STZ and BPA-treated rats showed functional variability in all hematologic parameters. The combination of STZ and BPA significantly reduced erythrocytes, leukocytes, and their associated parameters. However, QUE treatment alone or in combination corrected the altered hematologic parameters. The results of this study demonstrated that exposure to BPA in combination with STZ may alter hematologic indices, while QUE may be a therapeutic agent to correct the altered blood profile.

**Keywords:** *Bisphenol-A, Quercetin, Streptozocin, RBCs, WBCs.*

## 1. INTRODUCTION

Bisphenol A (BPA) is a chemical synthetic substance used in food and beverage packaging that disrupts the function of the endocrine system. People can be exposed to BPA through inhalation, dermal absorption, or orally [1]. BPA exposure may have harmful effects on human health [2]. Indeed, studies have reported that BPA may contribute to obesity, diabetes (DM), cancer, urogenital and immune system disorders [3]. In addition, there is a relationship between BPA and diabetes, and the active form of the estrogen hormone estradiol plays an important role. It has been suggested that

estradiol provides energy balance and glucose homeostasis and contributes to the maintenance of insulin sensitivity [4]. One Epidemiologic study reported that exposure to BPA may contribute to the etiology of Type 2 DM [5]. Furthermore, BPA has been shown to disrupt body functions, affect human and animal health even at low doses [1]. Indeed, BPA has been found in human blood, urine, milk, and urine, suggesting that it may pose risks to the metabolic function of the organism.

Flavonoids are a member of the polyphenolic class found in natural sources and have a variety of properties. Flavonoids are abundant in vegetables and fruits and are known to be the most effective antioxidants in nature. They protect the body against damage from reactive oxygen species. Quercetin (QUE) is one of the best-known polyphenols and is found in vegetables and fruits such as cabbage, apples, grapes, and broccoli. QUE is rich in vitamin C and has strong antioxidant activity, and previous studies have reported that QUE has anticancer, antibacterial, antidiabetic, and antiviral activities [6].

Streptozotocin (STZ) is one of the most widely used diabetogenic agents to create an experimental model of diabetes in animals. STZ blocks insulin release in the pancreas, leading to insulin-dependent DM. This is a toxic effect of STZ on beta cells. This cytotoxic effect is explained by the impairment of glucose-induced insulin secretion by inhibiting the signaling ability of mitochondrial metabolism in the cell [7]. STZ is a compound that damages organs by suppressing the immune system in the body. STZ injection also decreased white blood cells (WBC) and other hematologic parameters. It has been reported that this may be due to an inadequate defense system against inflammation and bone marrow depression [8].

Environmental toxins (BPA) may contribute to the pathogenesis of various diseases in the organism. There is also evidence that flavonoids such as quercetin may prevent the development of these diseases due to their antioxidant properties. This study aimed to investigate the effects of quercetin on some hematologic parameters against BPA exposure in STZ-induced rats.

## 2. MATERIALS AND METHODS

### 2.1. Chemicals

The chemicals used in the experiment, STZ (Merck) and Quercetin were obtained from Sigma-Aldrich, taking into account their purity ratios. Sodium citrate was purchased from Turkey. Blood was analyzed by following the procedures in the automatic hematology device.

### 2.2. Animal Material

This study was carried out using 72 female Wistar albino rats with a live weight of 200-250 g. The rats were housed in plastic cages at 22+/- 2 degrees Celsius and 12 hours of darkness/light. The animals were allowed free access to feed and water and were fed with pellet feed.

### 2.3. Experimental Groups

Rats were randomly divided into 9 groups with 8 animals in each group. Control received only saline (s.c.). BPA was dissolved in corn oil and administered by oral (po) gavage [9]. STZ was administered subcutaneously (s.c.) in a freshly prepared solution in 20 mM sodium citrate buffer (pH: 4.5) [10]. QUE was dissolved in saline and given i.p. at a dose of 15mg/kg [11]. The experimental procedure was established as follows.

**Group 1: (n=8)** Control (Saline),

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**Group 2: (n=8)** Corn oil (0.5 ml, solvent)
**Group 3: (n=8)** STZ (50 mg/kg),
**Group 4: (n=8)** BPA (10 mg/kg),
**Group 5: (n=8)** QUE (15mg/kg),
**Group 6: (n=8)** STZ (50 mg/kg) + QUE (15mg/kg),
**Group 7: (n=8)** BPA (10 mg/kg) + QUE (15mg/kg),
**Group 8: (n=8)** STZ (50 mg/kg ) + BPA group (10 mg/kg),
**Group 9: (n=8)** STZ (50 mg/kg ) + BPA (10 mg/kg) + QUE (15mg/kg).

### 2.4. Hematological Analysis

Blood samples were collected from the hearts of rats under anesthesia and transferred into anticoagulant (EDTA) tubes. in blood samples, Red blood cells (RBCs), hemoglobin (HGB) hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean cell hemoglobin concentration (MCHC), platelet (PLT), white blood Cells (WBC), neutrophils (NEUT), lymphocytes (LYMPH), monocytes (MONO), and eosinophils (EO) hematological variables were measured. These measurements were performed in the microbiology laboratory of Van Yüzüncü Yıl University Dursun Odabaş Medical Center.

### 2.5. Statistical Analysis

The statistical assessment of the collected data was expressed as the mean ± standard deviation (X ± SD). Continuous variables were compared among groups using One-way Analysis of Variance (ANOVA). Subsequently, post-analysis, the Duncan test was applied to identify distinctions between various groups. Significance levels were set at 5%, and the calculations were performed using the SPSS software program (IBM SPSS for Windows, version 26).

## 3. RESULTS

The hematological values obtained in the study were analyzed. RBC levels decreased in STZ and STZ+BPA groups, whereas increased in QUE-treated groups (STZ+QUE, BPA+QUE, and STZ+BPA+QUE) ($P<0.05$, Table 1, Figure 1). HGB levels were in parallel with RBC levels. The control group and QUE-treated groups were significantly higher than STZ (7.8 ± 0.80 10^3/µL ) and STZ+BPA (7.2 ± 0.45 10^3/µL) groups ($P<0.05$). HGB decreased with STZ and BPA and increased with QUE treatment. STZ+BPA group (12.7 ± 1.70 g/dL) had the lowest HGB value, while STZ+BPA+QUE group (16.8 ± 1.43 g/dL) had the highest value. In MCV, the STZ+BPA+QUE combination (64.5 ± 7.90 fL) had higher values compared to control (59.4 ± 1.39 fL) ($P<0.05$). There was no significant difference between the other groups ($P>0.05$). MCH and MCHC levels decreased in STZ+BPA and STZ+BPA+QUE groups compared to control groups. In MCH, the corn oil (18.1 ± 0.68 pg) group had the highest value, while STZ+BPA (17.2 ± 0.76 pg) and STZ+BPA+QUE (17.4 ± 0.31 pg) group had the lowest value. It was statistically significant when these groups were compared ($P<0.05$). PLT increased in QUE-treated groups and decreased in STZ and BPA-treated groups. While the PLT level showed a significant decrease in the STZ-only (643.0 ± 88,87 10^3/µL ) group, it surprisingly increased in the QUE-only (1298.1 ± 173.8 10^3/µL) group ($P<0.05$, Table 1). WBC levels decreased in STZ (6.3 ± 1.6 10^3/µL) and STZ+BPA (6.1 ± 1.3 10^3/µL) groups, whereas increased in corn oil (8.9 ± 0.5 10^3/µL) and STZ+QUE (8.2 ± 1.110^3/µL) groups ($P<0.05$). HCT level was parallel with HGB and RBC values. HCT decreased in STZ and BPA-treated groups, whereas it increased with QUE treatment ($P<0.05$, Table 2, Figure 2). NEUT levels decreased in the STZ+BPA (14.8 ± 0.5%) group and increased in the STZ+QUE (28.8 ± 4.7%) group and were found

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significant compared to the other groups (P<0.05). LYMPHs were significantly lower in STZ (60.7 ± 2.09%) and STZ+BPA (61.8 ± 2.57%) groups (P<0.05). MONO levels were higher in STZ-treated groups (1.13 ± 0.6%). EO was decreased in the BPA (0.21 ± 0.07%) and STZ+BPA (0.18 ± 0.07%) groups and significantly higher in the STZ+BPA+QUE (0.47 ± 0.08%) group (P<0.05). Changes in hematologic findings and comparisons between groups are shown in detail in Table 1-2 and Figure 1-2.

**Table 1**. The effect of STZ, BPA, and QUE singly and in combination on different hematologic variables (RBC, HGB, MCV, MCH, MCHC, and PLT).

| Groups | RBC (10^3/L) | HGB (g/dL) | MCV (fL) | MCH (pg) | MCHC (g/dL) | PLT (10^3/µL) |
|---|---|---|---|---|---|---|
| **Control** | 8.5±0.7$^{bc}$ | 15.5±1.1$^{abc}$ | 59.4±1.3$^{b}$ | 17.9±0.1$^{ab}$ | 30.7±1.0$^{a}$ | 938.8±109.7$^{bc}$ |
| **Corn oil** | 8.4±1.1$^{bc}$ | 14.5±0.8$^{c}$ | 61.9±1.3$^{ab}$ | 18.1±0.6$^{a}$ | 28.4±3.1$^{ab}$ | 871.5±105.3$^{bcd}$ |
| **STZ** | 7.8±0.8$^{cd}$ | 13.2±0.7$^{d}$ | 60.7±2.0$^{ab}$ | 17.7±0.4$^{ab}$ | 29.1±0.6$^{ab}$ | 643.0±88,87$^{d}$ |
| **BPA** | 8.4±0.9$^{bc}$ | 14.9±1.3$^{bc}$ | 61.0±1.8$^{ab}$ | 17.9±0.6$^{ab}$ | 29.3±0.6$^{ab}$ | 944.6±71.62$^{bc}$ |
| **QUE** | 10.3±1.3$^{a}$ | 14.5±0.5$^{c}$ | 60.4±2.9$^{ab}$ | 17.8±0.6$^{ab}$ | 29.4±0.5$^{ab}$ | 1298.1±173.8$^{a}$ |
| **STZ+QUE** | 8.3±0.3$^{bc}$ | 16,2±0.8$^{ab}$ | 61.3±3.2$^{ab}$ | 17.5±0.3$^{ab}$ | 28.7±0.4$^{ab}$ | 996.0±186.8$^{bc}$ |
| **BPA+QUE** | 9.3±0.3$^{b}$ | 14.8±0.6$^{c}$ | 61.2±3.2$^{ab}$ | 17.6±0.3$^{ab}$ | 28.9±1.4$^{ab}$ | 1114,0±239.6$^{ab}$ |
| **STZ+BPA** | 7.2±0.4$^{d}$ | 12.7±1.7$^{d}$ | 61.8±2.5$^{ab}$ | 17.2±0.7$^{b}$ | 28.2±0.9$^{b}$ | 771,8±136,1$^{cd}$ |
| **STZ+BPA +QUE** | 9.1±0.8$^{b}$ | 16.8±1.4$^{a}$ | 64.5±7.9$^{a}$ | 17.4±0.3$^{b}$ | 28.1±0.7$^{b}$ | 975.2±176.9$^{bc}$ |

Data are Mean ± SE; N = 8. Abbreviations: STZ= Streptozotocin; BPA= Bisphenol A; QUE= Quercetin; RBCs= Red blood cells; HGB= hemoglobin; MCV= mean corpuscular volume; MCH= mean corpuscular hemoglobin; MCHC= mean cellular hemoglobin concentration; PLTs= Platelets; $^{a,b,c,d}$ p: values with different letters are significant when compared with each other (p<0.05).

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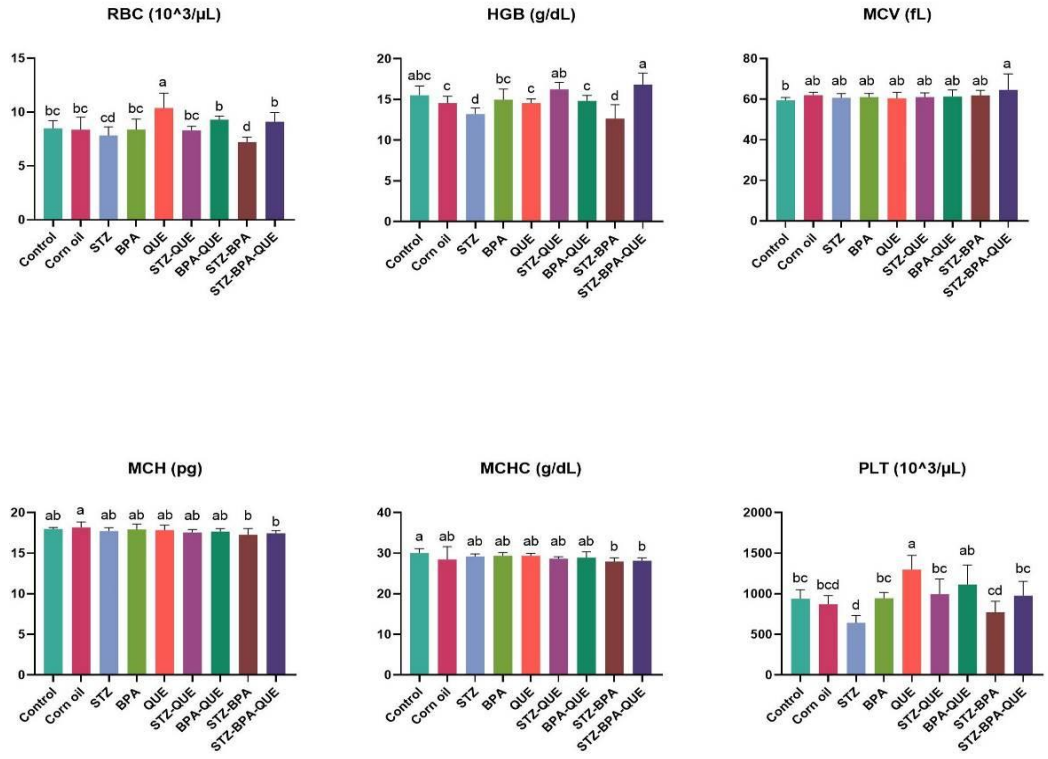


**Figure 1.** Effect of STZ, BPA, and QUE singly and in combination, on different hematologic variables. Data are Mean ± SE; N = 8. Abbreviations: STZ= Streptozotocin; BPA= Bisphenol A; QUE= Quercetin; RBCs= Red blood cells; HGB= hemoglobin; MCV= mean corpuscular volume; MCH= mean corpuscular hemoglobin; MCHC= mean cellular hemoglobin concentration; PLT= Platelet; $^{a,b,c,d}$ p: values with different letters are significant when compared with each other ($p<0.05$).

**Table 2.** The effect of STZ, BPA, and QUE singly and in combination on different hematologic variables (WBC, HCT, NEUT, LYMPH, MONO, and EO).

| Groups | WBC (10^3/L) | HCT (%) | NEUT (%) | LYMPH (%) | MONO (%) | EO (%) |
|---|---|---|---|---|---|---|
| **Control** | 7.9±1.3$^{a}$ | 64.0±8.0$^{a}$ | 18.2±2.9$^{b}$ | 80.0±3.2$^{a}$ | 0.98 ± 0.5$^{c}$ | 0.35±0.1$^{b}$ |
| **Corn oil** | 8.9±0,5$^{a}$ | 53.9±9.3$^{ab}$ | 19.4±1.2$^{b}$ | 80.7±5.4$^{a}$ | 0.67 ± 0.4$^{c}$ | 0.30±0.08$^{bc}$ |
| **STZ** | 6.3±1.6$^{b}$ | 49.1±1.8$^{c}$ | 19.2±2.4$^{b}$ | 60.7±2.0$^{b}$ | 1.13 ± 0.6$^{bc}$ | 0.28±0.09$^{bcd}$ |
| **BPA** | 7.9±1.6$^{a}$ | 51.2±2.8$^{ab}$ | 19.5±1.8$^{b}$ | 61.0±1.8$^{a}$ | 0.63 ± 0.2$^{c}$ | 0.21±0.07$^{cd}$ |
| **QUE** | 8.0±1.5$^{a}$ | 53.0±4.6$^{ab}$ | 20.4±1.5$^{b}$ | 60.4±2.9$^{a}$ | 0.63 ± 0.5$^{c}$ | 0.31±0.07$^{bc}$ |
| **STZ+QUE** | 8.2±1.1$^{a}$ | 56.7±3.4$^{b}$ | 28.8±4.7$^{a}$ | 61.3±3.2$^{a}$ | 1.10 ± 0.6$^{bc}$ | 0.35±0.05$^{b}$ |
| **BPA+QUE** | 7.5±1.0$^{ab}$ | 50.0±2.8$^{ab}$ | 21.7±5.0$^{b}$ | 61.2±3.2$^{a}$ | 1.01 ± 0.5$^{c}$ | 0.18±0.11$^{d}$ |
| **STZ+BPA** | 6.1±1.3$^{b}$ | 46.9±2.7$^{c}$ | 14.8±0.5$^{c}$ | 61.8±2.5$^{c}$ | 2.20 ± 0.6$^{a}$ | 0.18±0.07$^{d}$ |
| **STZ+BPA+QUE** | 7.4±0.6$^{ab}$ | 53.0±5.7$^{ab}$ | 20.7±3.2$^{b}$ | 64.5±7.9$^{a}$ | 1.60 ± 0.2$^{ab}$ | 0.47±0.08$^{a}$ |

Data Mean ± SE; N = 8. Abbreviations: STZ= Streptozotocin; BPA= Bisphenol A; QUE= Quercetin; WBCs= White blood cells; NEUTs= Neutrophils; LYMPHs= Lymphocytes; MONOs= Monocytes;

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Eosinophils= Eosinophils; [a,b,c,d]p: values with different letters are significant when compared with each other ($p<0.05$).

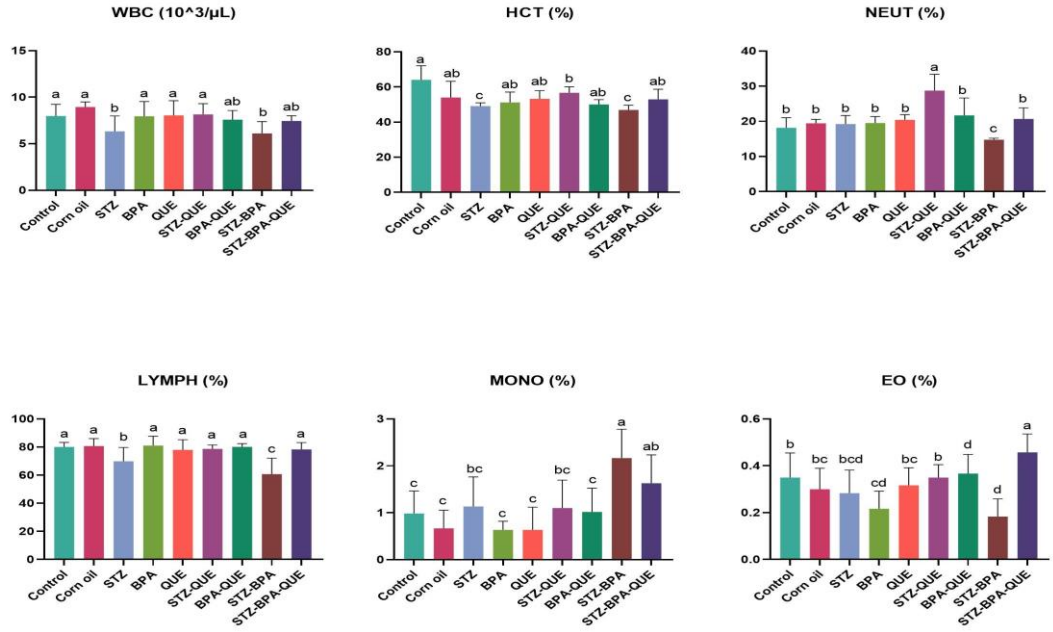


**Figure 2**. Effect of STZ, BPA, and QUE, singly and in combination, on different hematologic variables. Data are Mean ± SE; N = 8. Abbreviations: STZ= Streptozotocin; BPA= Bisphenol A; QUE= Quercetin; WBCs= White blood cells; NEUTs= Neutrophils; LYMPHs= Lymphocytes; MONOs= Monocytes; Eosinophils= Eosinophils; [a,b,c,d]p: values with different letters are significant when compared with each other ($p<0.05$).

## 4. DISCUSSION

The expansion of industrial production and increasing environmental toxins have had negative effects on the health of humans and animals. BPA is found in the structure of cheap plastic and polycarbonate products that are frequently used today and is an endocrine-disrupting environmental toxin. This toxin is thought to have many negative effects on health. Therefore the current study focused on the administration of STZ, BPA, and QUE either singly or in combination. STZ-treated rats induced changes in hematologic parameters. The results of this study support previous findings suggesting that STZ induces proliferation and apoptosis, especially in beta-cells [12, 13]. The basic mechanism of STZ in the body is antibody formation. These antibodies lead to degeneration of pancreatic beta cells and impaired insulin secretion [14]. Pancreatic damage leads to decreased insulin release and increased glucose in the blood [15]. The increase in circulating blood sugar can trigger oxidative stress and lead to a decrease in RBC and HGB values [16]. STZ has been found to decrease RBC and HGB levels. Because STZ-induced hyperglycemia causes dysfunction in the bone marrow. Accordingly, decreased HGB production may result in anemia. Furthermore, oxidation of membrane proteins leads to lipid peroxidation. This leads to hemolysis and shortened lifespan of the RBC [17]. In this study, it was found that the STZ+BPA combination decreased RBC and HGB

levels, while QUE treatment significantly restored them. BPA is an endocrine disruptor with estrogenic properties [18]. In a study conducted in male rats, it was reported to decrease erythropoiesis [19]. Walaa et al. (2015) suggested that BPA decreased RBC and HGB levels and increased anemia [20]. However, QUE is a flavonoid with potent antioxidant activity scavenging reactive oxygen species. This property of QUE has been reported to reduce the risk of several chronic diseases [21]. In addition, the oxidative stress-reducing effect of QUE has been reported to have positive effects on hematologic parameters [22]. HCT is expressed as a percentage of whole blood volume in relation to RBC. Increased HCT can cause polycythemia or dehydration. Decreased HCT may be due to renal failure, inflammation, and anemia [23]. STZ and BPA administration decreased the HCT level and QUE restored it. The decrease in the HCT index as a result of exposure to toxic agents is attributed to impaired hemostasis in blood and plasma osmolarity due to anemia [14]. The present results, in agreement with the literature, showed that STZ and BPA interacted to decrease RBC, HGB and HCT, while QUE normalized these values. STZ-treated rats exhibited a significant decrease in PLT levels. BPA administration did not produce a significant result on PLT levels. However, QUE treatment significantly increased PLT levels. Chronic diseases have been suggested to be markers for microvascular complications in diseases such as diabetes in which platelet indices are affected [24]. The decrease in STZ-administered rats indicates the effect of hyperglycemia as well as immune-induced suppression of hemopoiesis [22, 25, 26]. The low PLT level seen in STZ and BPA suggests that it may be due to a suppressed immune system. Although MCV, MCH, and MCHC levels were partially decreased in STZ and BPA groups compared to the control, it was not significant. However, the STZ+BPA+QUE combination was found to increase MPV levels compared to the other groups. These results are consistent with previous findings [20, 27]. STZ and STZ+BPA administration caused decreases in WBC and LYMPH counts. This is consistent with studies showing that STZ and BPA administration decreased these values [8, 20]. Decreased WBC and LYMPH may be related to the inhibition of leukocytosis due to increased inflammation with weakening of the immune system [14]. QUE supplementation significantly increased WBC and LYMPH counts to near control values. QUE is pleiotropic and reduces glucose absorption, insulin secretory, and insulin-sensitizing activities in the intestines [28]. QUE probably achieved this effect by controlling STZ-induced hyperglycemia and oxidative stress. NEUTs, EOs, and MONOs are blood cells that help the body maintain its immune system in various chronic diseases and inflammation. Decreased numbers of NEUTs and EOs result in delayed wound healing and prolonged inflammation resulting in morbidity and mortality in chronic diseases such as diabetes [14]. NUETs have been associated with decreased production of reactive oxygen species, protein glycosylation, and hyperglycemia [14]. EO is a multifunctional leukocyte involved in bacterial and viral infections, allergic and parasitic infections [29]. MONOs are cells involved in the synthesis and release of proinflammatory and oxidant cytokines in the organism. These cells are thought to contribute to the formation of microvascular diseases [30, 31]. STZ+BPA-treated rats showed a significant decrease in the number of NEUTs and EOs. However, MONOs were significantly increased in STZ and STZ+BPA-treated rats, whereas QUE treatment was found to decrease MONO levels. This result is in agreement with the previous study [22]. Rats receiving QUE exhibited a significant increase in these immune cells by preventing oxidative stress, and protein glycosylation. This study is in agreement with studies reporting an immune modulatory and potent radical scavenging effect of QUE [32, 33]. Therefore, QUE may have strengthened the body's defense system by increasing the formation of immune system cells.

## 5. CONCLUSION

This study focused on the possible changes in hematologic parameters of BPA, the most widely produced chemical in the world to which humans are constantly exposed, and the effect of QUE on these changes. STZ and BPA administration were found to decrease RBC, WBC, HGB, HCT, PLT, NEUT, LYMPH, and EO levels. However, QUE administration increased the decreased hematologic parameters. The findings show that STZ and BPA may interact synergistically and cause changes in hematological parameters. The negative impact of these toxic agents on hematological parameters can affect many physiological processes such as impairment of the body's defense system, anemia, decreased oxygen-carrying capacity of the blood, and coagulation factors. However, QUE possesses potent antioxidant activity, which may have contributed to its ability to restore STZ and BPA-induced changes in hematologic parameters. In conclusion, co-administration of BPA with STZ negatively affects hematologic parameters. QUE exhibited therapeutic activity to correct these parameters. More detailed studies are needed to understand the effects of BPA exposure on human health and the pharmacological efficacy of QUE.

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## ETHICS APPROVAL

This study was conducted with the approval of the local ethics committee of Van Yuzuncu Yil University (decision date 27.04.2023 and numbered 2023/06-07).

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**APPENDIX**

**VAN YÜHADYEK**
**VAN YÜZÜNCÜ YIL ÜNİVERSİTESİ**
**Hayvan Deneyleri Yerel Etik Kurulu**

**ÇALIŞMA ONAY BELGESİ**

***VAN YUZUNCU YIL UNIVERSITY (TURKEY)***
***ANIMAL RESEARCHES LOCAL ETHIC COMMITTEE***
***APPROVAL CERTIFICATE***

| | | |
|---|---|---|
| **Araştırmanın Adı:**<br>***Research Title:*** | Diyabetik ratlarda Bisfenol A maruziyetine karşı kuersetinin bazı hematolojik parametreler üzerine etkisi.<br>The effect of quercetin on some haematological parameters against Bisphenol A exposure in diabetic rats.ngilizce başlık buraya yazılmalıdır. | |
| **Araştırıcı(lar):** ***Investigator(s)*** | **Yürütücü / *Chief investigator:*** | Dr.Öğr.Ü. Yılmaz KOÇAK |
| | **Yardımcı Araştırıcı(lar) / *Co-investigator(s):*** | Prof. Dr. Gokhan OTO<br>Seray ALPARSLAN |
| **Araştırmada kullanılacak hayvanlar / *Animals to be used in the research:*** | | |
| **Tür / species:** *Wistar albino sıçan/ Wistar albino rat*<br>**Yaş /*Age:3-4 aylık/3-4 months old*** | **Sayı / *Numbers:*** *72*<br>**Cinsiyet / *Sex:*** *Dişi/ Female* | |
| Araştırmanın Öngörülen Başlama Tarihi / *Proposed Research Starting Date: 30.04.2023* | | |
| Araştırmanın Öngörülen Bitiş Tarihi / *Proposed Research Completion Date:14.05.2025* | | |

**Karar:**
Yukarıda bilgileri verilen planlanan araştırma projesi için Hayvan Deneyleri Etik Kurul Onayı gerekmemektedir.
Tarih: 27/04/2023; Karar No: 2023/06-07
***Decision:***
*The proposed research project detailed above does not need Animal Researches Ethic Committee Approval. Date* 27/04/2023 *Decision number* 2023/06-07

| | | |
|---|---|---|
| | **BAŞKAN V./CHAIR**<br>Prof. Dr. Yıldıray BAŞBUĞAN | |
| **ÜYE/Member**<br>Prof. Dr. N. Tuğba BİNGÖL | **ÜYE/Member**<br>Prof. Dr. Sıddık KESKİN | **ÜYE/Member**<br>Prof. Dr. Nalan ÖZDAL |
| **ÜYE**<br>Prof. Dr. Atilla DURMUŞ | **ÜYE/Member**<br>Prof. Dr. Semiha DEDE | **ÜYE/Member**<br>Doç. Dr. Ferda KARAKUŞ |
| **ÜYE/Member**<br>Doç. Dr. Canser Yılmaz DEMİR | **ÜYE/Member**<br>Doç. Dr. Abdulahad DOĞAN | **ÜYE/Member**<br>Doç. Dr. Şükrü ÖNALAN |
| **ÜYE/Member**<br>Dr. Öğr. Üyesi Dicle ALTINDAL | **ÜYE/Member**<br>Vet. Hek. İsmail Hakkı BEHÇET | **ÜYE/Member**<br>Zir. Müh. Kenan YILDIRIMOĞLU |