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The effect of bisphenol on blood parameters and reproductive physiology status in male local breed rabbits

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One of the most widely produced chemicals worldwide, bisphenol A is used in food and beverage packaging, water bottles, and dental sealants. Bisphenol A has become a possible hazard to many organisms, including public health, as a result of its widespread use. This research is aimed at showing the effect of bisphenol A on some hematological and reproductive parameters in male rabbits. The experiment was conducted from March 1, 2024, to May 2, 2025 at the University of Kerbala, the Faculty of Veterinary Medicine. The rabbits used in the experiment were housed in special cages. Twenty local breed rabbits were used, split into two groups. Every animal had been examined to ensure there were no injuries or anomalies before the experiment started. Ten rabbits in the control group (G1), were given tap water and pellets only, while group 2 (G2) was treated with bisphenol A (1 ml/kg) and additionally administered orally with water and pellets. The data from the experiment was analyzed using the SAS. In the second experiment, a one-way ANOVA was used, and the least significant differences (LSD) were utilized to ascertain whether the group indicators differed significantly. The results have shown that there are no significant differences in erythrocyte count between group 1 (C) and group 2 (T) after being treated with bisphenol A, while a significant decrease in hematological parameters such as leukocytes to 3.92 in the group treated with bisphenol suggested that bisphenol A has immunosuppressant action, also significant decrease in packed cell volume to 39.9 and hemoglobin concentration to 11.84 indicate that bisphenol A causes anemia. On the other hand, the reproductive hormones concentration shows that there is significant decrease in testosterone to 0.45 and estradiol 21.5 and indicate that bisphenol A cause hypogonadism in male rabbits. Thus, we see that bisphenol A has a negative effect on blood formation by significantly decreasing the packed cell volume ratio, hemoglobin concentration, white blood cells count and reproductive hormones (estrogen and testosterone concentrations) so it has a negative effect on rabbits' health.

Keywords: bisphenol A, blood parameters, testosterone, estrogen.

Вплив бісфенолу на гематологічні показники та концентрацію репродуктивних гормонів у самців кролів місцевих порід

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Бісфенол А – одна з найбільш вживаних хімічних речовин у світі, що входить до складу багатьох матеріалів. Її використовують у виробництві пакувань для продуктів харчування і напоїв, пляшках для води та, навіть, у стоматологічних герметиках. Як наслідок надмірного застосування Бісфенолу А у різних сферах, ця хімічна речовина наразі становить потенційну небезпеку для живих організмів, у тому числі людей. Здійсненим дослідженням колектив авторів мав на меті висвітлити на широкий загал результати впливу бісфенолу А на окремі гематологічні показники та репродуктивні гормони самців кролів. Експеримент проводився з 1 березня 2024 року по 2 травня 2025 року в Університеті Кербели, на факультеті ветеринарної медицини. Кролики, що використовувалися в експерименті, утримувалися в спеціальних клітках. Для досліду було задіяно двадцять кролів місцевих порід, яких розділили на 2 групи. Перша група кролів – G1 (n=10) – отримувала комбікорми і водопровідну воду та використовувалася, як контрольна. Друга група – G2 (n=10) – кролі цієї групи, окрім комбікорму та води, отримували бісфенол А. Дослідженнями встановлено, що внаслідок застосування кролям бісфенолу А відбулися певні зрушення в кровоносному руслі кролів. Зокрема, зафіксовано вірогідне (P<0,05) зниження кількості лейкоцитів (на 40,9 %), що свідчить про імуносупресивну дію бісфенолу А; вірогідне (P<0,05) зниження відсотка еритроцитів відносно загальної кількості крові (7,9 %) та вмісту гемоглобіну (на 13,8 %), що вказує на здатність бісфенолу А викликати анемію. Одночасно в сироватці крові дослідних кролів зафіксовано вірогідне (P<0,05) зниження концентрації репродуктивних гормонів – рівня естрогену (на 61,3 %) та тестостерону (на 76,4 %) відносно аналогічних показників у кролів контрольної групи. Зниження у сироватці крові кролів рівнів естрадіолу та тестостерону вказує на те, що бісфенол А викликає гіпогонадизм у самців кролів.

Ключові слова: бісфенол А, показники крові, тестостерон, естроген.

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Introduction

Bisphenol A (BPA), known as 2.2-bis (hydroxyphenyl), is plastic made using monomer and polycarbonate plastic. Recently, epoxy was removed from the list of drugs that disrupt hormones. This is due to its estrogenic effect (endocrine disrupting substances) [1]. Thomas Zinck of Marburg University in Germany used this compound by hand. Polycarbonate plastics and epoxy packaging for food boxes have been manufactured since 1950 [2]. When the British (Edward Carls-Doose) experimented using bisphenol as a synthetic estrogen at the start of the 1930s, they discovered that it had a 37,000-fold greater effect than estradiol, the active biologic form of estrogen. He found that bisphenol is not a drug, and in 1997, the negative effects of bisphenol at low concentrations were investigated in laboratory conditions on animals [3].

Many of the health effects of bisphenol were initially discovered accidentally. For example, in 1993, it was found that bisphenol leaches from polycarbonate flasks into the autoclave, which causes breast cancer cells to spread [4]. Condensing phenol with acetone produces bisphenol [5]. According to Zielińska et al. (2019) [6], it has a high melting point, low vapor pressure, moderate solubility, and evaporation ability. Less than 1 % of BPA is found in the ocean, where it is photooxidized and degraded. Additionally, it has a moderate capacity for rapid accumulation [7]. Moreover, it is found in the ocean alongside with suspended solids and has a moderate propensity to accumulate life [8]. Because of its relative alpha and beta binding strengths, BPA is a weak peripheral estrogen [9].

As it is known from the recent research, bisphenol can activate certain cellular reactions even at low concentrations, and in certain situations, bisphenol's estradiol equivalent [10]. Bisphenol's capacity to bind to estrogen receptors is responsible for some of its effects [11]. Targets have been proposed for a number of cell sites [12]. Additionally, it was supposed that certain metabolites of bisphenol may be more estrogenic than the original bisphenol [13]. Staples et al. (2002) verified that, actually, bisphenol and estrogen are similar. It should be remembered that a newborn baby's liver produces high amounts of alpha-fetoprotein when thinking about the effects of exposure to bisphenol after birth. It is the most significant plasma protein linked to estrogen in rodent development [14].

The aim of the study

The aim of this research is to study the effect of bisphenol on some hematological parameters and male sex hormones in male rabbits

Materials and methods

From March 1, 2024 to May 2, 2025, the experiment was carried out at the University of Kerbala, the Faculty of Veterinary Medicine. where the rabbits used in the experiment were housed in special cages.

Twenty rabbits were split into two groups.

Group 1 (C) consisted of ten rabbits receiving water and pellets was the control group.

Group 2 (T) consisted of ten rabbits receiving bisphenol A (1 milliliter per kilogram) for 40 days.

All animals were kept under suitable conditions.

Immunizations and preventive examinations.

Before the experiment began, every animal had been inspected to make sure there were no wounds or abnormalities. To prevent internal and external worms, the animals were given prophylactic doses of anti-helminthic preparations of Albendazole 3 % (administered internally) and Ivermectin 0.1 ml/rabbit (administered subcutaneously). To prevent coccidiosis, they received Amprolium for four days at a dose of 0.6 milliliters per liter of drinking water.

Blood tests.

At the beginning and end of the experiment, five milliliters of blood were extracted directly from the heart of each experimental animal. Blood parameters were measured in anticoagulant tubes, and male sex hormones were measured in gel tubes.

Complete blood count (CBC).

Following the collection and insertion of a blood sample into the Urit-2900 apparatus, the measurement was performed automatically (RBCs, WBCs, PCV and Hb).

Testosterone and estradiol.

The measurement was carried out automatically after the serum sample was collected and put into the Abbott i-1000 apparatus.

Statistical analysis.

The SAS (Statistical Analysis System, version 9.1) was used to analyze the experiment's data. For experiment two, a one-way ANOVA was used, and the least significant differences (LSD) were used to determine whether there were any significant differences between the group values. $P<0.05$ was deemed statistically significant, and the results were presented as mean ± standard errors.

Results and discussion

The findings were gathered to determine how bisphenol A affected the local breed rabbits' hematological parameters (RBCs, WBCs, PCV and Hb) as well as testosterone and estradiol reproductive hormones.

Table 1 shows that there are no significant differences in erythrocyte count between group 1 (C) and group 2 (T) after treatment with bisphenol A.

Table 1

The effect of bisphenol A on the rabbits' hematological parameters and reproductive hormones, Mean ± SE (N = 20)

Parameters	Control group, G1	Bisphenol A, G2	LSD values
RBCs, 10^6/mm^3	6.57±0.35 A	5.98±0.36 A	1.15
WBCs, 10^3/mm^3	6.63±0.98 A	3.92±0.52 B	2.5
Hb, g/dl	13.74±0.50 A	11.84±0.25 B	1.27
PCV, %	43.34±0.95 A	39.9±0.49 B	2.26
Estradiol, pg/ml	55.6±4.50 A	21.5±8.80 B	13.4
Testosterone, ng/ml	1.91±0.03 A	0.45±0.04 B	0.5

Note: RBCs – red blood cells; WBCs – white blood cells; Hb – hemoglobin; PCV – packed cell volume; different letters in the table indicate statistically significant differences between the groups (P<0.05).

A significant decrease in hematological parameters, such as leukocytes, in the treated group with bisphenol suggested that bisphenol has immunosuppressant properties. Additionally, a significant decrease in packed cell volume (by 39.9 %) and hemoglobin concentration (by 11.84 %) indicates that bisphenol may cause anemia.

On the other hand, the reproductive hormone concentrations show a significant decrease in testosterone (0.45) and estradiol (21.5), indicating that bisphenol causes hypogonadism in male rabbits.

One of the most widely produced chemicals worldwide, bisphenol A (BPA) is widely used in food and beverage packaging, water bottles, and dental sealants. BPA is now a possible hazard to many organisms, including public health, as a result of its widespread use. As the most prevalent cell type in the blood, erythrocytes play a crucial role in vital physiological processes like oxygen transportation. Since the blood contains a large number of xenobiotics, these substances may have an impact on red blood cells [15].

According to the current study, BPA negatively affected hemoglobin parameters. Likewise, BPA caused free radicals to form in the membrane of the red blood cells [16]. Because of its lipophilic nature, BPA may be cytotoxic to red blood cells. BPA has the potential to attach itself to hemoglobin's iron and cause it to separate from hemoglobin. Free iron may then promote lipid peroxidation. Furthermore, RBC damage from free radical formation and peroxidation may reduce their lifespan and result in early hemolysis [17].

BPA and other phenolic compounds oxidize iron in the heme molecule by generating superoxide radicals, which results in methemoglobin conversion [18]. The circulation quickly expels erythrocytes that contain methemoglobin [19]. Erythropoiesis disruption and/or increased red blood cell destruction have been demonstrated to be potential causes of the erythrocyte count decline [20]. In an in vitro study, human erythrocytes showed 96.20 % hemolysis at a dose of 150 µg/ml BPA [21]. BPA also causes oxidative damage in the bone marrow [22]. RBC destruction brought on by hemolysis and/or erythropoiesis disruption could account for the negative effects of BPA on hematologic parameters in our investigation.

According to Hananeh et al. (2021) [23], the decrease in WBC may have been brought on by the negative effects of microplastic accumulation, which damaged the body's hematopoietic system due to an increase in free radical production, thereby impairing the immune system's ability to function normally.

The testosterone level in the bisphenol A-intoxicated group was lower than that of the control group in the current study, in accordance with the findings of [24]. It was expected because bisphenol A has a corresponding cytotoxic effect on Leydig cells, which lower testosterone production.

Serum testosterone levels decreased less noticeably as BPA concentrations increased, despite a dose-dependent trend in CYP11A1 and StAR expression in this investigation. The complex process of testosterone synthesis includes the expression of steroidogenic enzymes such as CYP11A1 and StAR, as well as feedback mechanisms within the HPG axis.

Spörndly-Nees, [25] state that while lower doses of BPA may activate estrogenic pathways and initially stimulate testosterone synthesis, higher doses may disrupt the normal functioning of the HPG axis and lead to less testosterone production. Through its binding to estrogen receptors, BPA may have estrogenic effects that interfere with the regular feedback loops that regulate the release of gonadotropins such as LH and FSH. The interference may result in a dysregulated hormonal environment, which could explain the less obvious decline in testosterone levels, despite the obvious downregulation of key steroidogenic enzymes.

The potential for BPA-induced inflammation and oxidative stress also affect the expression of enzymes involved in testosterone synthesis and further complicate the relationship between BPA exposure and serum testosterone levels. Thus, this study demonstrated that at low BPA concentrations, E2 levels were higher than those of the control group, confirming the estrogenic effects of BPA [26]. As BPA shares structural similarities with estrogen, it can bind to estrogen receptors, activating estrogen response elements in cells and influencing cell growth, differentiation, and functioning (Wang et al., 2017) [27].

Conclusions

According to our findings, bisphenol A has a detrimental impact on blood formation by considerably lowering hemoglobin concentration, packed cell volume ratio, and white blood cell count, as well as reproductive hormones like testosterone and estrogen, which have a harmful effect on rabbit health.

Conflict of interest

The authors state that there is no conflict of interest.

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