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RESEARCH PAPER

TITLE:

**HAEMATOLOGICAL AND SEROLOGICAL EFFECTS OF
ENDOSULFAN IN DOMESTIC CHICKS (*GALLUS GALLUS
DOMESTICUS*)**

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HAEMATOLOGICAL AND SEROLOGICAL EFFECTS OF ENDOSULFAN IN DOMESTIC CHICKS (*GALLUS GALLUS DOMESTICUS*)

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ABSTRACT

Extensive use of pesticides for enhancing the crop production are widely use raising hazardous health issues. This study investigated the haematological, hormonal, and serological impacts of Endosulfan, a highly toxic organochlorine pesticide, on domestic chickens (*Gallus gallus domesticus*). In this study, chickens were divided into four groups. One group acted as Control while other three groups exposed to different doses @ 5mg/kg, 15mg/Kg and 25 mg/kg respectively of Endosulfan over 90 days. Blood samples were analyzed for parameters including RBC, WBC, hemoglobin, platelets, and hormone levels (testosterone), alongside serological and behavioral assessments. It was observed that Endosulfan exposure led to changes in blood cell counts and hormone levels. Red blood cell (RBC) and white blood cell (WBC) counts increased, likely due to the body's response to the pesticide's toxicity. However, platelet numbers decreased in some cases. Additionally, it was observed a decrease in testosterone levels. It was concluded that endosulfan create harmful effects on chickens' health and emphasizes the need to reduce pesticide use to protect both animals and the environment. Banning highly toxic pesticides like Endosulfan should be done for the safeguard ecosystems and human health.

Key words: Organochlorine pesticide; Haematological disruption; Hormonal alteration; Oxidative stress; Environmental

Pollution

INTRODUCTION

Pesticides, like Endosulfan, are commonly used worldwide to control pests in farming and other areas. However, they're a big problem for the environment. They can harm many different living things, from people to plants to animals on land and in water. When these pesticides spread, they affect lots of creatures because everything in nature relies on each other for food and homes. These are toxic chemicals and pollute environment. So, when animals and plants are exposed to these harmful chemicals, it messes up their bodies and produce deleterious effects (Sathishkumaret al., 2021; Zafar et al., 2024). Endosulfan is a powerful pesticide, similar to other chemicals like Aldrin, used to control insects. Unfortunately, it's harmful to birds and other animals (Riyaz et al., 2021). Endosulfan affects the bodies of various animals, like mammals, birds, and fish, and found it can mess up their blood, nerves, and immune systems (Kumar et al., 2024). Pesticides are causing big problems for birds nowadays. Chickens, which are commonly eaten worldwide, are especially affected because they eat grains and veggies treated with pesticides (Alem, 20024). These chemicals mess with their bodies and can even harm their organs. Plus, when birds eat crops sprayed with pesticides, they get sick too (Ali et al., 2021).

Pesticides are used to get rid of pests that harm plants, animals, and people. But they end up hurting lots of creatures, including us when we eat animals that have been exposed to pesticides. (Khang et al., 2024). They can damage organs like the liver, kidneys, and heart, and they're even known to cause heart problems in some animals. These chemicals mess with blood and body chemistry too, causing all sorts of issues (El-Nahhal, & El-Nahhal, 2021).

All types of pesticides can harm chickens. There are four main groups of pesticides: organophosphates, organochlorines, carbamates, and pyrethroids. These chemicals affect the organs and blood of chickens (Tang et al., 2025). Organochlorines are particularly bad for the liver and kidneys. Scientists use different methods to study how pesticides affect chicken meat, depending on the situation. It's important for food safety authorities to make rules about pesticide use to protect people who eat chicken (Osaili et al., 2023).

The biochemistry of birds is also affected by Endosulfan exposure, and their blood parameters are disrupted by various pesticides such as organochlorines, DDT, and their derivatives like Endosulfan. Organochlorine compounds are commonly used to control environmental pollution and reduce avian predators in nature. However, these chemicals also interfere with the normal blood profile of many bird species. Researchers have collected blood samples from affected birds and observed significant changes in blood cell counts, which in some cases lead to cancerous cell formation. The number of blood cells often differs noticeably from that of healthy birds (Jayakumar, et al.,

2020).

Persistent organic pollutants (POPs) can weaken the immune system of seabirds and other wildlife. Researchers have found that pesticides have a harmful impact on the immune systems of animals in the wild too (Jara, et al., 2018). Keeping in view the importance of biochemical effects of organochlorine pesticide, this study will design to identify the haematological and serological effects of endosulfan in domestic chicks (*Gallus gallus domesticus*).

MATERIAL & METHODS

The study utilized total of 40 domestic chickens (*Gallus gallus domesticus*) of six month sourced from local markets were purchased and set up in metal cages at Minhaj University Lahore. They stayed in a comfortable environment at normal room temperature and divided into four groups, a control group A and three experimental groups B, C, D respectively. Each group contain total of 10 chickens. For they got used to their new environment and felt comfortable, the chicken started feed and had access to clean, cool water for drinking After a week of acclimation, group B were administered Endosulfan (Thiodan 35% EC) at doses of @5 mg/kg, group C @15 mg/kg, and group D were given @25 mg/kg, with three replicates of each group respectively.

Required dose = Chick Weight x Dose concentration.

To start the experiment, the weight of each chicken also recorded and it helped us to determine how much oral dose of the pesticide to give them. Every week, body weight was measured to see if there are any changes in their weight.

Chickens from each group B, C, D were euthanized on days 30, 60, and 90 for analysis. Over a 90-day period, the pesticide was orally delivered via saline solution, and the blood samples were collected monthly from each group near the jugular vein for haematological, hormonal, and serological



profiling. Then labelled the blood samples and placed them in containers for analysis of blood profile in the laboratory. It was looked at various aspects of the chicken's behaviour and health. For clinical signs, it had used a score ranging from 0 to 4, with 4 being the most severe.



Figure 1: Collecting blood from the chicken's neck vein

Haematological analysis

Haematological parameters, including packed cell volume (PCV), red blood cells (RBC), platelets, white blood cells (WBC), haemoglobin concentration, and leukocyte differentials (heterophils, lymphocytes, monocytes, eosinophils, and basophils), as well as indices such as MCV, MCH, MCHC, and RDW, were measured using standard procedures. Techniques such as the microhematocrit method and the cyanmethemoglobin method were applied.

Microhematocrit Procedure

The hematocrit test was used to determine the quantity of red blood cells in total blood volume of the chick. Blood samples were gathered in capillary tubes for

centrifugation. The packed cell volume (PCV) was then analysed and expressed as a percentage or a decimal fraction. This method provided correct assessment of blood composition in the experimental chickens B, C, and D.

Cyanmethemoglobin Method

To determine the haemoglobin concentration cyanmethemoglobin method was used, which based on spectrophotometric measurement of a cyanide derivative. For this examination, blood samples were diluted with a reagent containing potassium cyanide and potassium ferricyanide. It was seen that the red blood cells were lysed, forming a unchanging haemoglobin solution appropriate for measurement.

Hormonal Analysis

Hormonal analysis was conducted to calculate testosterone levels by using ELISA. Furthermore, serological tests were performed to calculate the total protein and albumin concentrations. Mortality was noted in high dose group D (25 mg/kg dose), where one out of three chickens died. Behavioural abnormalities, including reduced mobility and tumor development, near neck area were also examined. These serological assessments confirmed a complete evaluation of the physiological and ecological effects of Endosulfan on chickens.

Statistical Analysis

Data was analysed by using ANOVA to find the dose-dependent and time-dependent effects of Endosulfan on haematological and serological parameters of chicken in experimental and control group. The results were stated as Mean $\pm$ SE, with the statistical significance considered at $P < 0.05$.

RESULTS

The study evaluated the effect of Endosulfan on haematology and serology of chicken. The results showed in Table 1, showed significant changes in blood and serum biochemistry of chickens. At 30 days of post-exposure, a significant decline ($p < 0.05$) was observed in Mean $\pm$ SE values of key erythrocyte parameters, including red blood cell (RBC) count, packed cell volume (PCV), and hemoglobin (Hb) concentration, signifying an initial toxic haemolytic activity. A pronounced thrombocytopenia was also evident.

The most marked effect was on the endocrine system, with serum testosterone levels

decreasing precipitously from a control value of 100.0 ± 2.2 ng/mL to 5.9 ± 0.0 ng/mL. By days 60 and 90, a robust compensatory response was observed. RBC count, PCV, and Hb not only recovered but significantly exceeded control values, indicating reactive erythropoiesis. A significant leukocytosis was also recorded, alongside elevated counts of heterophils, monocytes, eosinophils, and basophils, pointing towards a sustained inflammatory and immune response to the ongoing oxidative stress. The Mean $\pm$ SE values of platelet counts initially decreased significantly in groups (B, C, D) @ 5 mg dose in but increased slightly at higher doses over time, due to thrombocytosis as compared to control group (A).

Serum total protein levels were variable, with a marked increase at 30 days (5 mg,) followed by a decrease at higher doses in group (D) and later stages, indicating impaired protein synthesis as compared to control(A)

Table 1: Haematological and serological parameters of chicks @5mg/kg of Endosulfan

Parameter	Control	30 Days	60 Days	90 Days
RBC ($\times 10^6/\mu\text{L}$)	4.3 $\pm$ 0.0 ^{cd}	2.6 $\pm$ 0.09 ^e	3.9 $\pm$ 0.0 ^d	4.5 $\pm$ 0.1 ^{bc}
Packed cell volume (PCV) (%)	35.0 $\pm$ 0.8 ^c	13.4 $\pm$ 0.4 ^d	43.6 $\pm$ 1.2 ^{ab}	48.2 $\pm$ 1.1 ^a
Hemoglobin (g/dL)	11.1 $\pm$ 0.3 ^d	4.4 $\pm$ 0.0 ^e	14.5 $\pm$ 0.2 ^a	11.8 $\pm$ 0.1 ^{cd}
Mean corpuscular volume (MCV) (fL)	83.0 $\pm$ 2.3 ^b	51.1 $\pm$ 1.9 ^c	111.3 $\pm$ 5.1 ^a	115.1 $\pm$ 5.0 ^a
Mean corpuscular haemoglobin (MCH) (pg)	24.6 $\pm$ 1.1 ^b	16.9 $\pm$ 0.5 ^c	36.9 $\pm$ 0.7 ^a	38.8 $\pm$ 1.0 ^a
Mean corpuscular haemoglobin concentration (MCHC) (g/dL)	32.1 $\pm$ 0.8 ^a	33.1 $\pm$ 0.6 ^a	33.2 $\pm$ 0.9 ^a	33.1 $\pm$ 0.6 ^a
Red cell distribution width (RDW) (%)	14.95 $\pm$ 0.40 ^b	13.80 $\pm$ 0.32 ^{bc}	14.20 $\pm$ 0.21 ^b	17.22 $\pm$ 0.2 ^a
WBC ($\times 10^3/\mu\text{L}$)	10.7 $\pm$ 0.2 ^c	6.91 $\pm$ 0.1 ^d	14.9 $\pm$ 0.1 ^a	11.0 $\pm$ 0.31 ^c

Heterophils (%)	58.0±2.8 ^b	22.1±0.5 ^c	27.0±0.5 ^c	59.0±0.6 ^b
Lymphocytes (%)	60.0±1.8 ^b	61.1±2.4 ^b	69.0±1.2 ^{ab}	76.00±2.0 ^a
Monocytes (%)	6.0±0.1 ^b	2.0±0.0 ^e	2.0±0.0 ^e	7.2±0.2 ^a
Eosinophils (%)	9.0±0.2 ^d	0.0±0.0 ^e	0.0±0.0 ^e	13.0±0.3 ^a
Basophils (%)	0.4±0.0 ^c	0.0±0.0 ^d	0.0±0.0 ^d	3.1±0.0 ^a
Platelets (×10 ³ /μL)	412.0±11.0 ^{abc}	125.0±6.4 ^f	259.0±20.0 ^e	262.0±21.9 ^e
Testosterone (ng/mL)	100.0±2.2 ^e	5.9±0.0 ^f	3.4±0.0 ^f	3.1±0.0 ^f
Serum Total Protein (g/dL)	3.3±0.0 ^{ef}	10.9±0.5 ^a	2.5±0.1 ^f	3.2±0.0 ^f
Serum Albumin (g/dL)	0.3±0.0 ^e	1.0±0.0 ^d	0.5±0.0 ^e	0.4±0.0 ^e

Same letters within a row or column show there is no significant difference ($P>0.05$). Lowercase letters are used to compare the combined effects (interactions) of the groups.

The medium dose group in Table, 2 exhibited a more complex pattern of disruption, particularly within the immune and endocrine systems. The variance values of red cell distribution width (RDW) showed a significant increase, particularly at 90 days with 15 mg doses in experimental groups (B, C, D) suggesting anisocytosis and RBC size variability as compared to control group (A). Erythrocytic parameters (RBC, PCV, Hb) remained relatively stable and within physiological ranges as compared to control group A. However, leukocyte differential analysis revealed a state of chronic

inflammation, indicated by a significant and persistent elevation in heterophil counts.

Concurrently, a significant lymphocytopenia was observed, indicating a potential suppression of the adaptive immune response. A paradoxical and non-monotonic effect was noted on hormonal balance. At 30 days, a significant hyperstimulation occurred, with testosterone levels significantly increase to 249.4 ± 12.6 ng/mL as compared to control group A. This was followed by a significant decline to hypogonadal levels (26.0 ng/mL) at 60 and 90 days, suggesting an exhaustive failure of steroidogenic pathways following initial overstimulation.

Table 2: Haematological and serological parameters of chicks @15mg/kg of Endosulfan

Parameter	Control	30 Days	60 Days	90 Days
RBC ($\times 10^6/\mu\text{L}$)	4.3 $\pm$ 0.0 ^{cd}	4.4 $\pm$ 0.1 ^{bcd}	4.7 $\pm$ 0.1 ^{abc}	4.7 $\pm$ 0.1 ^{abc}
Packed cell volume (PCV) (%)	35.0 $\pm$ 0.8 ^c	37.9 $\pm$ 1.6 ^{bc}	40.9 $\pm$ 1.3 ^{bc}	43.8 $\pm$ 3.0 ^{ab}
Hemoglobin (g/dL)	11.1 $\pm$ 0.3 ^d	12.6 $\pm$ 0.3 ^{bc}	13.6 $\pm$ 0.1 ^{ab}	11.6 $\pm$ 0.1 ^{cd}
Mean corpuscular volume (MCV) (fL)	83.0 $\pm$ 2.3 ^b	85.9 $\pm$ 2.9 ^b	88.9 $\pm$ 2.0 ^b	89.8 $\pm$ 3.1 ^b
Mean corpuscular haemoglobin (MCH) (pg)	24.6 $\pm$ 1.1 ^b	28.5 $\pm$ 0.8 ^b	27.5 $\pm$ 0.5 ^b	27.7 $\pm$ 0.8 ^b
Mean corpuscular haemoglobin concentration (MCHC) (g/dL)	32.1 $\pm$ 0.8 ^a	33.2 $\pm$ 0.8 ^a	31.2 $\pm$ 0.7 ^{ab}	33.1 $\pm$ 0.5 ^a
Red cell distribution width (RDW) (%)	14.9 $\pm$ 0.4 ^b	13.8 $\pm$ 0.3 ^{bc}	17.8 $\pm$ 0.5 ^a	18.7 $\pm$ 0.2 ^a
WBC ($\times 10^3/\mu\text{L}$)	10.7 $\pm$ 0.2 ^c	11.2 $\pm$ 0.2 ^{bc}	10.5 $\pm$ 0.2 ^c	12.0 $\pm$ 0.2 ^b

Heterophils (%)	58.0±2.8 ^b	71.0±2.3 ^a	72.0±1.8 ^a	74.0±2.0 ^a
Lymphocytes (%)	60.0±1.8 ^b	27.0±0.5 ^d	29.0±0.5 ^d	49.0±1.2 ^c
Monocytes (%)	6.0±0.1 ^b	2.0±0.0 ^e	6.0±0.1 ^b	6.3±0.3 ^b
Eosinophils (%)	9.0±0.2 ^d	0.0±0.0 ^e	0.00±0.0 ^e	10.1±0.2 ^c
Basophils (%)	0.4±0.0 ^c	0.00±0.00 ^d	0.00±0.0 ^d	2.0±0.0 ^b
Platelets (×10 ³ /μL)	412.0±11.0 ^{abc}	391.0±15.3 ^{a-d}	421.0±6.9 ^{ab}	421.0±15.7 ^{a^b}
Testosterone (ng/mL)	100.0±2.2 ^e	249.4±12.6 ^b	26.0±0.5 ^f	26.0±0.7 ^f
Serum Total Protein (g/dL)	3.3±0.0 ^{ef}	3.0±0.0 ^f	6.7±0.2 ^b	4.0±0.0 ^{de}
Serum Albumin (g/dL)	0.3±0.0 ^e	1.3±0.0 ^b	0.6±0.0 ^d	1.5±0.0 ^a

Same letters within a row or column show there is no significant difference ($P>0.05$). Lowercase letters are used to compare the combined effects (interactions) of the groups.

The highest dose of endosulfan in Table 3, elicited responses indicative of severe systemic toxicity and immunosuppression. The Mean± SE values of red blood cell count (RBC) significantly increased with exposure to Endosulfan, particularly at 25 mg/kg over 90 days in experimental groups (B, C, D) compared to the control group A. Similarly, packed cell volume (PCV) also showed a significant increase, especially at higher doses @25mg/kg in Table 3 and longer durations, reflecting enhanced oxygen-carrying capacity in response to stress as compared to control group.

Contrary to the lower doses, the high-dose group exhibited significant leukopenia, with the total white blood cell (WBC) count significantly falling in experimental groups B, C, and D as compared to control group A. This suggests a suppressive toxic effect on haematopoietic tissues or a severe compromise of immune function.

The endocrine disruption followed a similar pattern to the medium-dose group but was more extreme, with testosterone levels peaking at 598.7 ± 44.8 ng/mL at 30 days before declining as compared to control group A. Furthermore, significant increases in eosinophils and basophils were noted,

reflecting a state of heightened immunological stress and dysregulation. Monocyte counts showed a slight increase, especially at 90 days in the 25 mg group while eosinophils and basophils both increased significantly in the higher dose group (D), when compared to control group A. The Mean $\pm$ SE values of heterophils also increased significantly in experimental groups (B, C, and D), especially at higher doses, reflecting inflammatory responses. Across all treated groups, a significant increase in Red Cell Distribution Width

(RDW) was consistently observed, confirming the presence of anisocytosis and impaired erythropoiesis due to toxic stress. Serum albumin showed slight but significant increases at higher doses in experimental groups C and D, particularly in the 15 mg and 25 mg groups, in Table 1 and 3 possibly reflecting compensatory liver activity as compared to control group (A).

Table 3: Haematological and serological parameters of chicks @25mg/kg of Endosulfan

Parameter	Control	30 Days	60 Days	90 Days
RBC ($\times 10^6/\mu\text{L}$)	4.3 $\pm$ 0.0 ^{cd}	4.5 $\pm$ 0.0 ^{bc}	4.9 $\pm$ 0.0 ^{ab}	5.2 $\pm$ 0.1 ^a
Packed cell volume (PCV) (%)	35.0 $\pm$ 0.8 ^c	35.9 $\pm$ 1.5 ^c	38.3 $\pm$ 0.7 ^{bc}	39.3 $\pm$ 1.4 ^{bc}
Hemoglobin (g/dL)	11.1 $\pm$ 0.3 ^d	10.8 $\pm$ 0.1 ^d	11.7 $\pm$ 0.2 ^{cd}	12.8 $\pm$ 0.5 ^{bc}
Mean corpuscular volume (MCV) (fL)	83.0 $\pm$ 2.3 ^b	86.4 $\pm$ 1.8 ^b	87.4 $\pm$ 1.2 ^b	88.4 $\pm$ 1.1 ^b
Mean corpuscular haemoglobin (MCH) (pg)	24.6 $\pm$ 1.1 ^b	25.20 $\pm$ 0.6 ^b	26.10 $\pm$ 0.2 ^b	28.10 $\pm$ 1.0 ^b
Mean corpuscular	32.1 $\pm$ 0.8 ^a	28.00 $\pm$ 0.7 ^b	31.00 $\pm$ 0.8 ^{ab}	33.00 $\pm$ 0.6 ^a

haemoglobin concentration (MCHC) (g/dL)				
Red cell distribution width (RDW) (%)	14.9±0.4 ^b	11.10±0.3 ^d	11.20±0.0 ^d	12.20±0.3 ^{cd}
WBC (×10 ³ /μL)	10.7±0.2 ^c	5.52±0.0 ^f	5.63±0.0 ^{ef}	6.60±0.1 ^{de}
Heterophils (%)	58.0±2.8 ^b	70.00±2.1 ^a	71.70±1.1 ^a	76.20±2.9 ^a
Lymphocytes (%)	60.0±1.8 ^b	63.20±2.6 ^b	64.30±2.3 ^b	66.20±1.7 ^b
Monocytes (%)	6.0±0.1 ^b	2.20±0.0 ^e	3.40±0.1 ^d	4.40±0.0 ^c
Eosinophils (%)	9.0±0.2 ^d	9.20±0.2 ^{cd}	9.30±0.2 ^{cd}	11.20±0.2 ^b
Basophils (%)	0.4±0.0 ^c	2.10±0.0 ^b	2.10±0.0 ^b	3.10±0.1 ^a
Platelets (×10 ³ /μL)	412.0±11.0 ^{abc}	346.0±18.5 ^{bcd}	328.0±13.6 ^{de}	333.0±18.9 ^{cde}
Testosterone (ng/mL)	100.0±2.2 ^e	598.7±44.8 ^a	187.6±4.5 ^{bc}	176.60±13.40 ^{cd}
Serum Total Protein (g/dL)	3.3±0.0 ^{ef}	4.3±0.0 ^{cd}	3.20±0.07 ^{ef}	5.00±0.09 ^c
Serum Albumin (g/dL)	0.3±0.0 ^e	0.5±0.0 ^{de}	0.40±0.1 ^e	0.60±0.0 ^d

Same letters within a row or column show there is no significant difference ($P>0.05$). Lowercase letters are used to compare the combined effects (interactions) of the groups.

The physiological disturbances were directly reflected in the growth performance of the birds (Figure 1). Final body weight was significantly higher ($p > 0.05$) in all Endosulfan-treated groups (B, C, D)

compared to the control group (A). This clear growth increase demonstrates that the metabolic cost of combating toxic stress energy resources away from somatic development and abnormal growth.

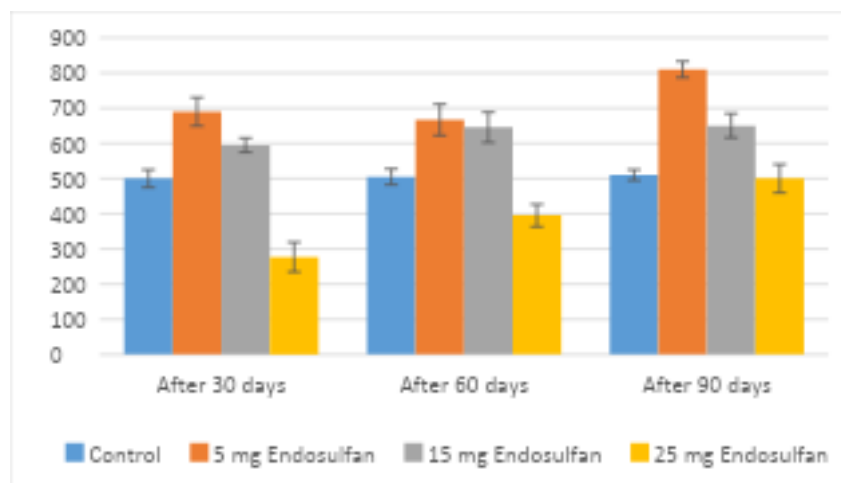


Fig 2: Analysis of Body weight in experimental groups (B, C, D) and control group (A)

DISCUSSION

The study investigated how Endosulfan, a highly toxic pesticide, affects the blood and hormone levels of domestic chickens. It was examined various blood cell types, such as red blood cells, white blood cells, platelets, and other factors like haemoglobin levels, comparing them to a control group (A). The levels of total protein, albumin, and testosterone, in experimental groups (B, C, and D) were also analysed comparing them with the control group. The results showed significant changes as compared to the control group A. Precisely, the number of red blood cells increased in experimental groups B, C, and D over time as compared to control

when exposed to Endosulfan, likely due to oxidative stress. In this study, it was found that exposure of pesticides like Endosulfan can lead to various changes in the blood of chicken. The oxidative stress caused by these chemicals can shorten the lifespan of red blood cells (RBCs), prompting the bone marrow to produce more RBCs to compensate. Previous study has revealed heavy metal exposure and insecticide poisoning can also contribute to an increase in RBCs (Attarchi et al., 2022).

Present study also showed the platelets increased in experimental groups as compare to control group, likely due to swelling in the body organs and oxidative stress, which

leading to a condition called thrombocytosis. Studies have also shown that organophosphorus compounds can affect megakaryocytes, leading to an increase in platelets. Incomplete activation and impaired aggregation of platelets can also contribute to their increase in number. (Huang, et al., 2019).

Additionally, the lymphocytes and monocytes also increased in experimental groups (B, C, D) as compared to control group (A) in our study. This may be accredited to the increased toxicity of the blood caused by pesticide exposure. Some studies showed the long-term exposure to insecticides can lead to long-lasting inflammation, which disturbed the number of monocytes (Alemu, et al., 2025).

Similarly, the red cell distribution width (RDW) increased in the present study due to inflammation and oxidative stress in relation to control group A. Some studies also revealed inflammation caused by pesticide exposure (Khan et al., 2019).

Furthermore, it was also detected an increase in the number of white blood cells in experimental groups (WBCs) in our study when compared with control (A). In the present study an increase in the number of white blood cells (WBCs), which play a crucial role in regulating the body's immune function and defence system. The study has shown the increase likely reflects the body's protective response to stress (Saha, et al., 2024).

The study revealed the levels of hemoglobin (Hb) and packed cell volume (PCV) increased, in experimental groups (B, C, D) possibly due to higher organophosphate levels. Previous studies shown when the PCV

rises, so does the Hb content, improving the blood's oxygen-carrying capacity, especially in stressful situations (Sinha, et al., 2022). Additionally, variations in red blood cell (RBC) size led to increases in mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), and mean corpuscular hemoglobin (MCH).

Moreover, it was observed an increase in heterophils in all experimental groups in a comparison to the control group (A). So, according to previous studies this rise might indicate increased toxicity in the blood and body organs, evident in microscopic organ changes (Begum et al., 2015).

The hormonal tests using ELISA showed a decrease in testosterone levels in this study. The decline could be affecting the processes like sperm production and fertility, potentially impacted by pesticide exposure (Mittra & Maitra, 2018). Endosulfan, may lower steroid levels by boosting their breakdown and elimination. Some studies suggest pesticides can directly inhibit steroid production. The body weight of all the treated groups increases in our study due to the toxic stress and lack of energy resources to somatic cell and abnormal cell growth.

No significant difference in albumin levels compared to the control group but total protein levels slightly increased. This elevation could stem from pesticide exposure, which might disrupt serum protein levels by affecting liver protein synthesis and kidney function (Yassin & Al-Shanti, 2016).

CONCLUSION

The study revealed that Endosulfan exposure induced haematological and hormonal alterations in domestic chickens, including

elevated RBC, WBC, and haemoglobin levels, alongside thrombocytopenia and testosterone suppression. These findings underscored risks to avian health, ecological balance, and food safety. Prioritizing regulatory measures, including banning Endosulfan, was critical to reducing environmental contamination and safeguarding public health. To reduce the risk of diseases and environmental pollution, it's recommended to ban the use of such harmful pesticides and protect bird populations.

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