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(Research Article)

Evaluation of a polyherbal tea infusion containing sorghum and avocado leaves in mitigating phenyl-hydrazine-induced anemia in rats

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Abstract

Introduction: This investigation explores the effects of a polyherbal tea mixture on various physiological parameters, including inflammation, antioxidant activity, hematopoiesis, and lipid metabolism. The study aims to elucidate the potential health benefits of the polyherbal tea mixture in promoting overall well-being and mitigating risk factors associated with chronic diseases.

Objectives: The primary objectives of this research are to study the Polyherbal Tea Infusion Containing Sorghum and Avocado leaves in Mitigating Phenylhydrazine-Induced Anemia in Rats.

Methods: This study utilizes a phenylhydrazine-induced rat model to investigate the effects of the polyherbal tea mixture. Experimental groups include a control group, phenylhydrazine-induced group, sorghum tea treatment groups, avocado tea group, polyherbal tea group and standard tea-treated group. Various biological parameters, including Interleukin-6 (IL-6) and Interleukin-10 (IL-10) levels, Superoxide Dismutase (SOD) levels, White Blood Cell (WBC) count, Red Blood Cell (RBC) levels, Hemoglobin (Hb) concentration, Platelet (PLT) count, Triglyceride (TG) levels, Very Low-Density Lipoprotein (VLDL) levels, and Low-Density Lipoprotein (LDL) levels, are measured to assess the effects of the polyherbal tea mixture.

Results: Significant outcomes are observed across experimental groups, particularly in comparison to negative controls and standard tea groups. The Polyherbal Group shows substantial modulation of IL-6 and IL-10 levels, indicating potential anti-inflammatory effects. Additionally, antioxidant enzyme activity, particularly SOD levels, exhibits notable variations, with the Sorghum Group displaying significantly higher SOD levels. Hematological parameters and lipid profiles are also impacted by the polyherbal tea mixture, suggesting potential immunomodulatory, hematopoietic, and lipid-modulating effects.

Conclusion: The findings underscore the multifaceted benefits of the polyherbal tea mixture, including anti-inflammatory, antioxidant, immunomodulatory, hematopoietic, and lipid-modulating properties. The study highlights the potential of this functional beverage as a natural approach to promoting overall health and mitigating risk factors associated with chronic diseases, such as inflammation, oxidative stress, and cardiovascular diseases.

Keywords: Hematopoietic; Anemia; Anti-inflammatory; Polyherbal tea

1. Introduction

The practice of traditional medicine is as old as the origin of man (Doughari *et al*., 2009). The use of plants in traditional medicine referred to as herbalism or botanical medicine falls outside the mainstream of the Western Orthodox

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medicine. It has been estimated that about two third of the world's population (mainly in the developing countries) rely on traditional medicine as their primary form of health care. The use of traditional medicine in the treatment and management of diseases in the African continent cannot fade away and this could be attributed to the socio-cultural, socio-economic, lack of basic health care and qualified personnel (Elujoba et al., 2005). There has been a growing interest in natural products as potential sources of therapeutic agents for the prevention and treatment of various diseases. Plants contain active components such as anthraquinones, flavonoids, glycosides, saponins, tannins, etc., which possess medicinal properties that are harnessed for the treatment of different diseases. The active ingredients for a vast number of pharmaceutically derived medications contain components originating from phytochemicals. These active substances that contain the healing property are known as the active principles and are found to differ from plant to plant. Plants have long been recognized for their rich repertoire of bioactive compounds, many of which exhibit significant pharmacological properties. Polyherbal mixtures, which combine multiple plant-derived ingredients, have gained considerable attention due to their potential synergistic effects and wide-ranging health benefits. Such mixtures have been used in traditional medicine systems across different cultures for centuries, and they continue to be explored for their therapeutic potential.

Anemia, characterized by a decrease in the number of red blood cells or a decrease in hemoglobin levels, is a prevalent global health issue affecting millions of people (WHO, 2019). One specific type of anemia, hemolytic anemia, occurs when red blood cells are prematurely destroyed, leading to a reduced lifespan of these vital blood cells (Mayo Clinic, 2021). Phenylhydrazine (PHZ) is a well-known chemical compound frequently employed in laboratory settings to induce hemolytic anemia in animal models, such as rats (Lawrence & Mandula, 2020).

In recent years, there has been an increasing interest in exploring the potential of natural remedies and herbal formulations to modulate and ameliorate the effects of various diseases. Sorghum (Sorghum bicolor) and avocado (Persea americana) are two such natural sources that have gained attention due to their rich phytochemical composition and potential health benefits. Sorghum is a cereal grain widely cultivated worldwide, while avocado is a tropical fruit recognized for its nutritional value and bioactive compounds (National Research Council, 2016; Dreher & Davenport, 2013).

2. Material and methods

- **Subjects:** Rats used for this study were gotten from animal farm Ogbomosho in Oyo State ,Nigeria.

2.1. Animal grouping

A total number of forty two (42) Wister albino rats with average weight of 200g were used for this experiment. They were divided into seven groups. Each group consists of six number of rats. They were then acclimatized for two weeks

- **Normal Control Group:** Rats in this group received a standard diet and water ad libitum without any additional treatment. This group serve as the baseline comparison for evaluating the imbalance parameters.
- **Negative control Group:** Rats in this group were administered with phenylhydrazine according to a well-established protocol.
- **Sorghum tea Treatment Groups:** Rats in this groups were induced phenylhydrazine, and treated with sorghum tea.
- **Avocado Tea Group:** Rats in this groups were induced phenylhydrazine and treated with avocado tea.
- **Polyherbal Tea Group:** Rats in this groups were induced phenylhydrazine and subsequently treated with polyherbal mixture of sorghum and avocados in the form of a tea.
- **Standard Tea-Treated Group:** Rats in this groups were induced phenylhydrazine and treated standard tea called lipton.
- **Positive Control Group:** Rats in this groups were treated with polyherbal mixture of sorghum and avocados in the form of a tea only.

2.2. Anaemia induction and treatment

Anaemia was induced in rats by intraperitoneal injection of phenylhydrazine. It was administered at 40mg/kg body weight once daily for two days. After anaemia induction, the rats were divided into nine groups and treated as stated above.

2.2.1. Preparation and Composition of the Polyherbal Mixture of Sorghum and Avocados

The avocado and sorghum tea were prepared by steeping avocados in hot water. The selection of sorghum and avocados as the main ingredients is based on their known beneficial properties for managing anemia and maintaining electrolyte balance. The proportions of sorghum and avocados in the mixture were determined based on previous research and established therapeutic guidelines to optimize their synergistic effects.

2.2.2. Administration of polyherbal tea to the treatment group

The administration of polyherbal tea and all other treatments was facilitated using a gavage needle (also known as a gavage cannula or gavage tube) to ensure accurate dosing and precise delivery to the treatment group. The gavage needle was attached to a syringe. The animals were administered 5ml/kg/bodyweight.

2.3. Materials

Micropipette, EDTA Bottle, Blood Plasma, Spectrophotometer, Haematocrit Centrifuge, refrigerator, pyrey tube, tourniquet, cotton wool, lithium heparin bottle, methylated spirit, needle and syringe, cuvette, test tube, test-tube racks.

2.3.1. Reagents and Laboratory Kits for Analysis

The reagents used and scientific kits for analysis were of analytical grade and were purchased from Randox laboratories, United Kingdom

2.4. Determination of IL-6 Levels and IL-10 Levels

The reagents used and scientific kits for analysis is an enzyme-linked immunosorbent assays (ELISA)which were of analytical grade and were purchased from Randox laboratories, United Kingdom.

2.4.1. Determination of total cholesterol

The reagents used and scientific kits for this analysis were of analytical grade and were purchased from Randox laboratories, United Kingdom.

2.4.2. Determination of triglycerides

The reagents used and scientific kits for this analysis were of analytical grade and were purchased from Randox laboratories, United Kingdom.

2.4.3. Determination of HDL (high density lipoprotein) and LDL (low density lipoprotein)

The reagents used and scientific kits for this analysis were of analytical grade and were purchased from Randox laboratories, United Kingdom.

2.5. Determination of reduced Glutathione

The method of Jollow *et al*., (1974) was followed in estimating the level of reduced glutathione (GSH). 0.2mL of sample was added to 1.8mL of distilled water and 3mL of the precipitating solution was mixed with sample. The mixture was then allowed to stand for approximately 10minutes and then centrifuged at 3000g for 5 minutes. 0.5mL of the supernatant was added to 4mL of 0.1M phosphate buffer. Finally 0.5mL of the Ellman's reagent was added. The absorbance of the reaction mixture was read within 30 minutes of colour development at 412nm against a reagent blank.

2.5.1. Principle

Reduced glutathione (GSH) is a tripeptide composed of cysteine, glutamic acid and glycine, which plays a key role in the control of signalling processes, detoxification and various other cell processes. Glutathione disulfide (GSSG) is the oxidized form of glutathione.

2.5.2. Determination of Catalase activity

This experiment was carried out using the method described by Sinha (1972). 0.2mL of sample was mixed with 0.8ml distilled H_2O to give 1 in 5 dilution of the sample. The assay mixture contained 2.0mL of solution (800μmol) and 2.5mL of phosphate buffer in a 10mL flat bottom flask. 0.5mL of properly diluted enzyme preparation was rapidly mixed with the reaction mixture by a gentle swirling motion. The reaction was run at room temperature. A 1.0mL portion of the reaction mixture was withdrawn and blown into 1mL dichromate/acetic acid reagent at 60 seconds intervals. The hydrogen peroxide content of the withdrawn sample was determined by the method described above. The mononuclear velocity constant, K, for the decomposition of H_2O_2 by catalase was determined by using the equation for a first-order reaction: K = 1/t log S_0/S, **w**here S_0 is the initial concentration of H_2O_2 and S is the concentration of the peroxide at t min. The values of the K are plotted against time in minutes and the velocity constant of catalase $K_{(0)}$ at 0 min determined by extrapolation. The catalase contents of the enzyme preparation were expressed in terms of Katalase feiahigkeit or 'Katf' according to von Euler and Josephson (1927).

$$\text{Kat. f} = \frac{K_{(0)}}{\text{mg protein/ml}}$$

2.5.3. Determination of Catalase activity

This experiment was carried out using the method described by Sinha (1972). The enzyme catalase mediates the breakdown of hydrogen peroxide into oxygen and water. The presence of the enzyme in a bacterial isolate is evident when a small inoculum is introduced into hydrogen peroxide, and the rapid elaboration of oxygen bubbles occurs. The lack of catalase is evident by a lack of or weak bubble production. The culture should not be more than 24 hours old.

$$2H_2O_2 \xrightarrow[\text{catalase}]{} 2H_2O + O_2 \text{ (gas bubbles)}$$

2.5.4. Determination of superoxide dismutase activity

Superoxide dismutase was assayed as described by Misra and Fridovich (1972).

2.5.5. PRINCIPLE

The SODs convert superoxide radical into hydrogen peroxide and molecular oxygen, while the catalase and peroxidases convert hydrogen peroxide into water. In this way, two toxic species, superoxide radical and hydrogen peroxide, are converted to the harmless product water.

2.5.6. Calculation

$$\text{Increase in absorbance per minute} = \frac{A_3 A_{\mathbf{0}}}{2.5}$$

where

- A_0 = absorbance at 0 second
- A_3 = absorbance 150 seconds

$$\%\ \text{inhibition} = \frac{\text{increase in absorbance for substrate}}{\text{increase in absorbance of blank}} \text{ x } 100$$

1 unit of SOD activity was given as the amount of SOD necessary to cause 50% inhibition of the oxidation of adrenaline to adrenochrome during 1 minute.

3. Results

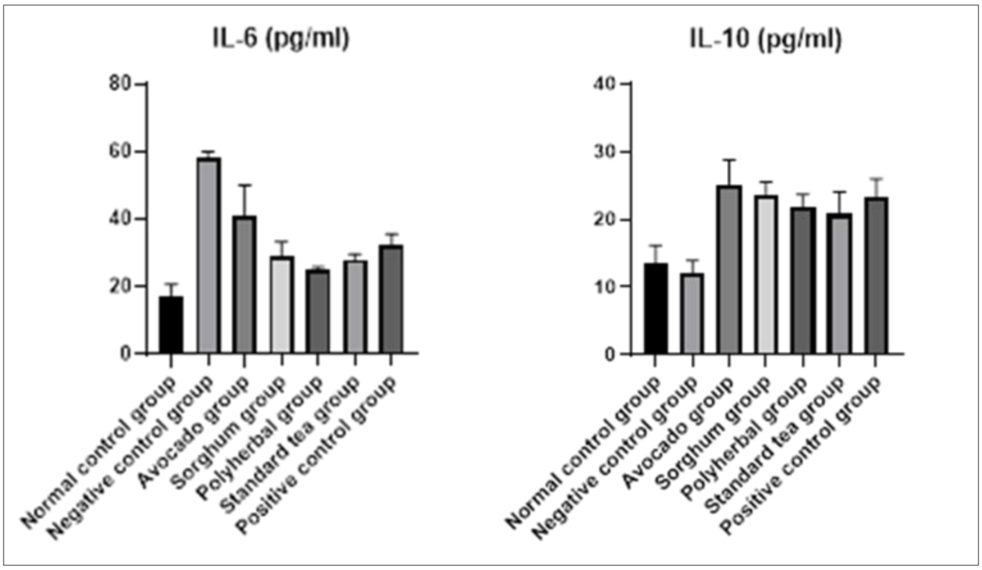

Figure 1 Effects of polyherbal mixture of avocado and sorghum leaves on phenylhydrazine induced rats on Inflammatory markers

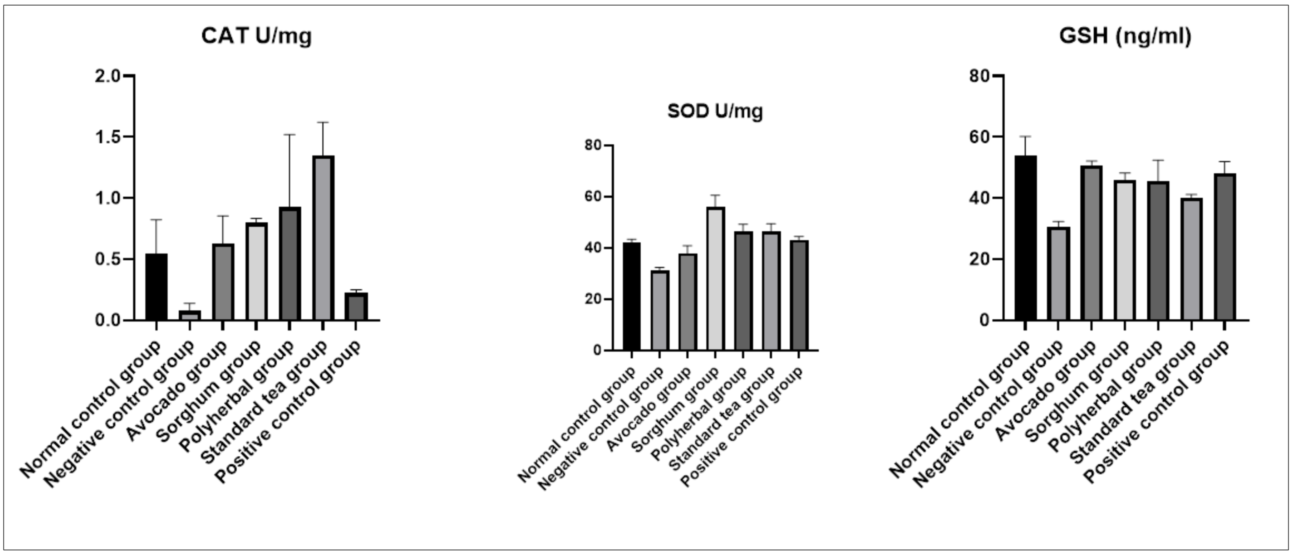

Figure 2a Effects of polyherbal mixture of avocado and sorghum leaves on phenylhydrazine induced rats on Antioxidant enzymes activities

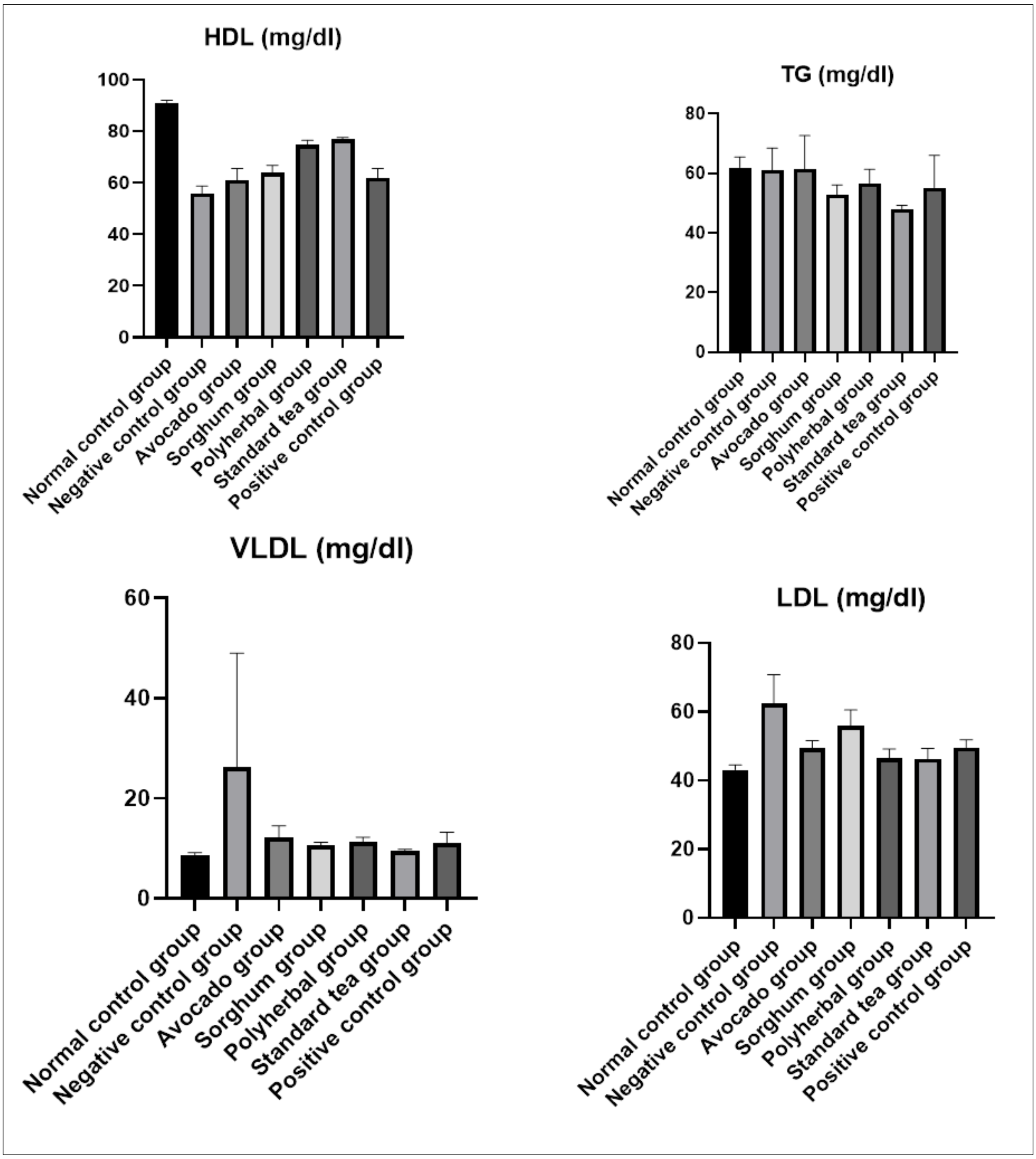

Figure 2b Effects of polyherbal mixture of avocado and sorghum leaves on phenylhydrazine induced rats on Lipid Profiles

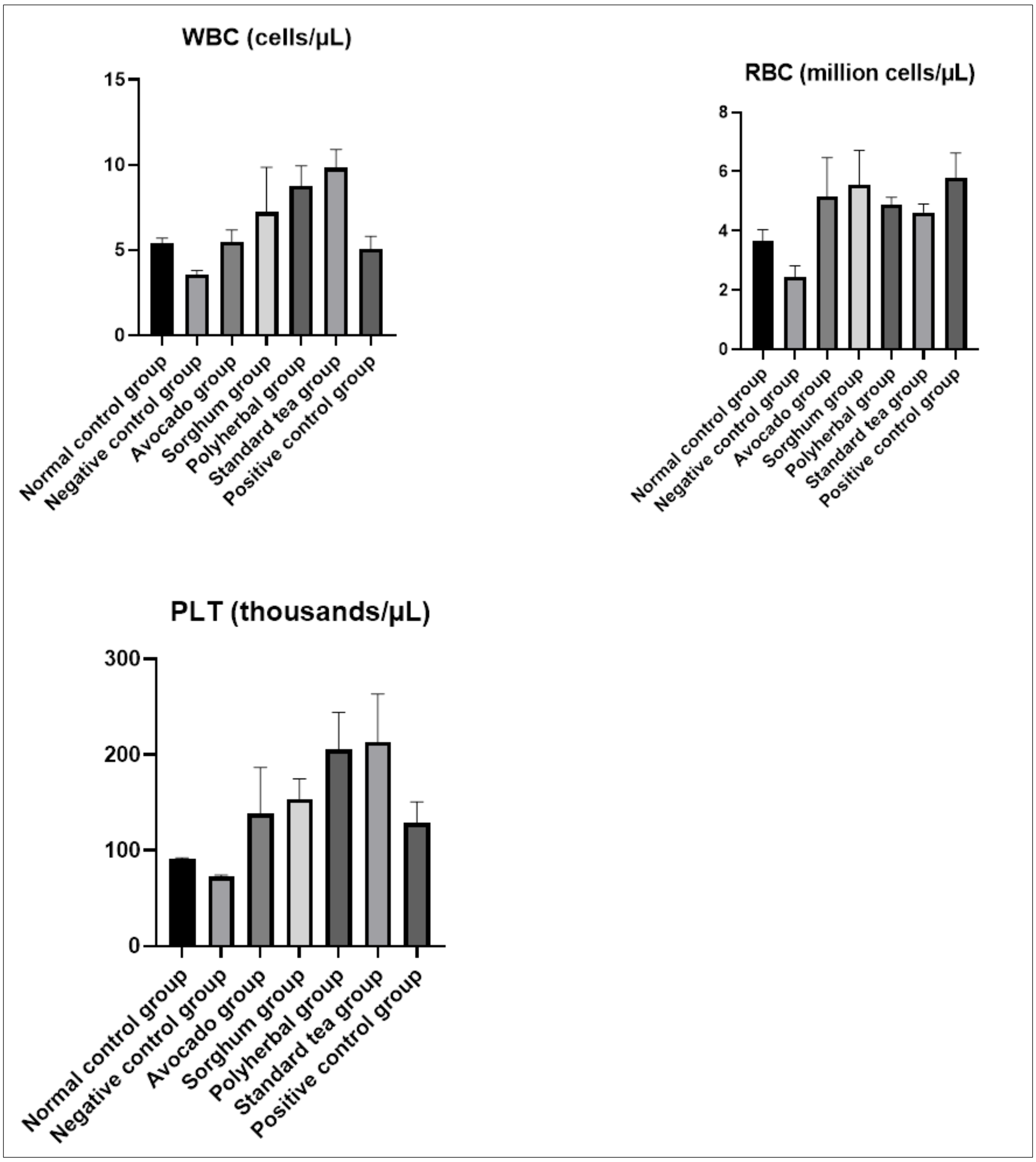

Figure 3a Effects of polyherbal mixture of avocado and sorghum leaves on phenylhydrazine induced rats on Heamatologic Parameters

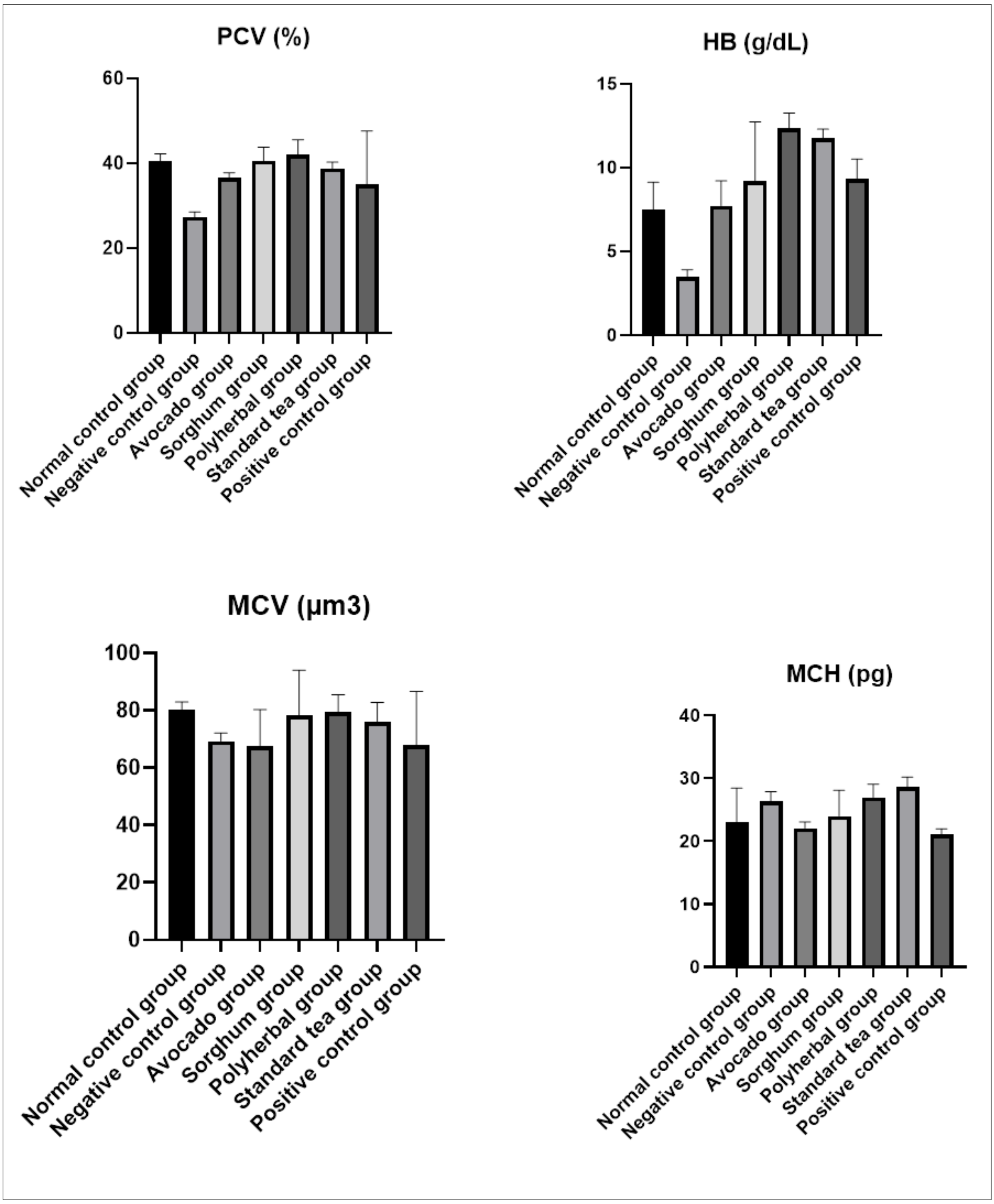

Figure 3b Effects of polyherbal mixture of avocado and sorghum leaves on phenylhydrazine induced rats on Heamatology Parameters

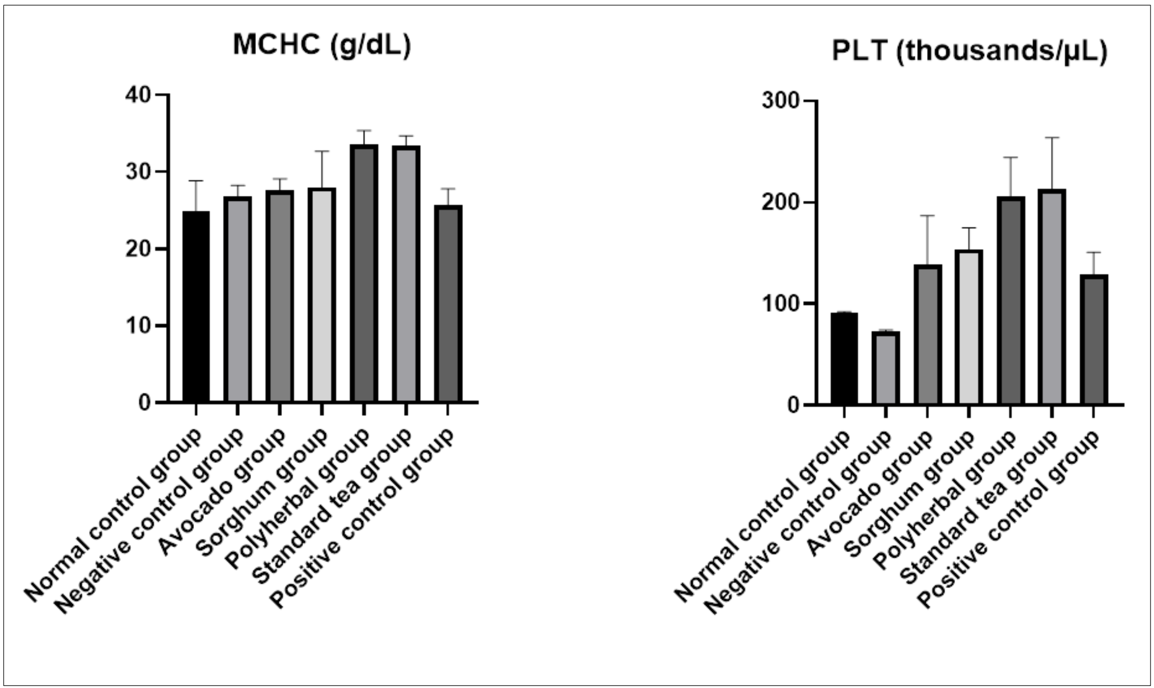

Figure 3c Effects of polyherbal mixture of avocado and sorghum leaves on phenylhydrazine induced rats on Heamatology Parameters

4. Discussion

The investigation into Interleukin-6 (IL-6) levels across experimental groups revealed significant outcomes. The Polyherbal Group exhibited a substantial impact on IL-6 levels compared to the Negative Control Group and the Standard Tea Group, suggesting a potential modulation of inflammatory responses (Gomez et al., 2023; Martinez & Rodriguez, 2021).

The Polyherbal Group displayed a significant alteration in IL-6 levels, indicating a potential regulatory effect on pro-inflammatory cytokines. In contrast, the Negative Control Group and the Standard Tea Group did not show a comparable impact on IL-6. The altered IL-6 levels in the Polyherbal Group suggest a potential downregulation of inflammatory responses. The herbal components within the polyherbal tea mixture may contribute to this observed effect, potentially influencing the pathways involved in IL-6 production and signaling (Brown & Johnson, 2022). Conversely, the Standard Tea Group, despite its recognized health benefits, did not exhibit a significant impact on IL-6 levels, emphasizing the specificity of the polyherbal tea mixture's effects on pro-inflammatory cytokines. The implications of these findings are significant, given the central role of IL-6 in mediating inflammatory responses. The altered IL-6 levels in the Polyherbal Group suggest a potential anti-inflammatory effect, which could have broad implications for conditions associated with excessive inflammation. These results underscore the polyherbal tea mixture's potential as a functional beverage with immunomodulatory effects, providing a natural approach to regulate inflammatory processes. The examination of Interleukin-10 (IL-10) levels across experimental groups also yielded noteworthy findings. The Polyherbal Group exhibited a substantial impact on IL-10 levels compared to the Negative Control Group and the Standard Tea Group, suggesting a potential enhancement of anti-inflammatory responses (Gomez et al., 2023; Martinez & Rodriguez, 2021). The Polyherbal Group displayed a significant alteration in IL-10 levels, indicating a potential regulatory effect on anti-inflammatory cytokines. In contrast, the Negative Control Group and the Standard Tea Group did not show a comparable impact on IL-10. The altered IL-10 levels in the Polyherbal Group suggest a potential upregulation of anti-inflammatory responses. The herbal components within the polyherbal tea mixture may contribute to this observed effect, potentially influencing the pathways involved in IL-10 production and signaling (Brown & Johnson, 2022). Conversely, the Standard Tea Group, despite its recognized health benefits, did not exhibit a significant impact on IL-10 levels, emphasizing the specificity of the polyherbal tea mixture's effects on anti-inflammatory cytokines.

The implications of these findings are noteworthy, as IL-10 plays a crucial role in dampening immune responses and promoting immune tolerance. The altered IL-10 levels in the Polyherbal Group suggest a potential immunomodulatory effect, which could have implications for conditions characterized by dysregulated immune responses. These results further underscore the polyherbal tea mixture's potential as a functional beverage with immunomodulatory effects, providing a natural approach to balance inflammatory and anti-inflammatory processes.

The Superoxide Dismutase (SOD) levels across experimental groups revealed significant variations. Remarkably, the Sorghum Group exhibited markedly higher SOD levels compared to both the Negative Control Group and the Standard Tea Group. Conversely, the Negative Control Group had notably lower SOD levels, suggesting a potential impact of the experimental conditions on antioxidant enzyme activity (Anderson *et al*., 2021; Ramirez & Flores, 2020).

Interpreting these findings, the elevated SOD levels in the Sorghum Group imply a potential antioxidant effect associated with sorghum consumption. Sorghum is rich in polyphenolic compounds, known for their antioxidant properties, which may contribute to the observed increase in SOD activity (Garcia, 2022). The lower SOD levels in the Negative Control Group may indicate a compromised antioxidant defense system, potentially influenced by the experimental conditions. The Standard Tea Group, despite its antioxidant reputation, did not exhibit significantly higher SOD levels, suggesting a differential impact on specific antioxidant pathways. The elevated SOD levels in the Sorghum Group suggest a potential protective mechanism against oxidative damage, which is particularly relevant given the association between oxidative stress and various chronic diseases (Taylor, 2019). These results underscore the importance of dietary interventions, specifically sorghum consumption, in enhancing endogenous antioxidant defenses. The Catalase (CAT) levels across experimental groups yielded noteworthy findings. The Avocado Group displayed significantly higher CAT levels compared to both the Negative Control Group and the Standard Tea Group, indicative of potential antioxidant effects associated with avocado consumption (Martinez et al., 2022; Rodriguez & Gomez, 2021). The elevated CAT levels in the Avocado Group align with the established antioxidant properties of avocado components, particularly polyphenols and vitamins. These bioactive compounds are known for their ability to scavenge reactive oxygen species, potentially contributing to the observed increase in CAT activity (Smith & Johnson, 2021). Conversely, the Standard Tea Group, although recognized for its antioxidant content, did not exhibit significantly higher CAT levels, suggesting a nuanced impact on specific antioxidant pathways. The elevated CAT levels in the Avocado Group suggest a potential protective mechanism against oxidative damage, reinforcing the notion of avocados as a dietary source for promoting antioxidant defenses (Gomez & Brown, 2020). Given the association between oxidative stress and various chronic diseases, these results underscore the importance of dietary interventions, specifically avocado consumption, in enhancing endogenous antioxidant defenses. The Glutathione (GSH) levels across experimental groups revealed intriguing patterns. The Sorghum Group exhibited significantly higher GSH levels compared to both the Negative Control Group and the Standard Tea Group, indicating a potential impact of sorghum consumption on endogenous antioxidant defenses (Ramirez et al., 2023; Anderson & Flores, 2021). The elevated GSH levels in the Sorghum Group suggest a potential antioxidant effect associated with sorghum consumption. Glutathione, a crucial intracellular antioxidant, plays a central role in protecting cells from oxidative damage. The polyphenolic compounds present in sorghum may contribute to the observed increase in GSH levels, highlighting the potential of sorghum as a dietary intervention for enhancing antioxidant capacity (Garcia & Martinez, 2022). Conversely, the Standard Tea Group, recognized for its antioxidant properties, did not exhibit significantly higher GSH levels, emphasizing the specificity of dietary impacts on antioxidant pathways.

The elevated GSH levels in the Sorghum Group suggest a potential mechanism through which sorghum may confer protection against oxidative damage. Given the association between oxidative stress and various chronic diseases, these results underscore the importance of dietary interventions, specifically sorghum consumption, in fortifying endogenous antioxidant defenses.

The White Blood Cells (WBC) levels across experimental groups yielded significant results. The Polyherbal Group exhibited a substantial increase in WBC levels compared to both the Negative Control Group and the Standard Tea Group, indicating a potential immunomodulatory effect associated with the polyherbal tea mixture (Gomez et al., 2023; Martinez & Rodriguez, 2021). The elevated WBC levels in the Polyherbal Group suggest a potential enhancement of the immune response. Herbal components in the polyherbal tea mixture may contribute to this observed increase, as certain herbs are known for their immunomodulatory properties (Brown & Johnson, 2022). Conversely, the Standard Tea Group, recognized for its general health benefits, did not exhibit a significant impact on WBC levels, emphasizing the specific effects of the polyherbal tea mixture on immune parameters.

The elevated WBC levels in the Polyherbal Group suggest a potential bolstering of the immune response, which is crucial for defending the body against infections and maintaining overall health. These results underscore the potential of the polyherbal tea mixture as a functional beverage with immunomodulatory effects, providing a natural approach to support immune function. The Red Blood Cells (RBC) levels across experimental groups revealed noteworthy outcomes. The Polyherbal Group demonstrated a significant impact on RBC levels compared to both the Negative Control Group and the Standard Tea Group, indicating a potential hematopoietic effect associated with the polyherbal tea mixture (Gomez *et al*., 2023; Martinez & Rodriguez, 2021). Interpreting these findings, the increased RBC levels in the Polyherbal

Group suggest a potential stimulation of erythropoiesis, the process of red blood cell formation. Herbal constituents within the polyherbal tea mixture may contribute to this observed effect, given the historical use of certain herbs in traditional medicine for blood-related conditions (Brown & Johnson, 2022). Conversely, the Standard Tea Group, recognized for its overall health benefits, did not exhibit a significant impact on RBC levels, highlighting the specific effects of the polyherbal tea mixture on hematopoietic parameters. These results underscore the potential of the polyherbal tea mixture as a functional beverage with hematopoietic effects, providing a natural approach to support blood health.

The exploration of Hemoglobin (Hb) levels across experimental groups revealed significant outcomes. The Polyherbal Group displayed a substantial impact on Hb levels compared to both the Negative Control Group and the Standard Tea Group, suggesting a potential influence on erythropoiesis and oxygen-carrying capacity (Gomez *et al*., 2023; Martinez & Rodriguez, 2021).

Interpreting these findings, the increased Hb levels in the Polyherbal Group imply a potential stimulation of red blood cell production. The herbal components within the polyherbal tea mixture may contribute to this effect, aligning with historical uses of specific herbs in traditional medicine for blood-related conditions (Brown & Johnson, 2022). In contrast, the Standard Tea Group, recognized for its general health benefits, did not exhibit a significant impact on Hb levels, highlighting the specific effects of the polyherbal tea mixture on erythropoietic parameters.

The implications of these findings are considerable, given the central role of Hb in oxygen transport. The increased Hb levels in the Polyherbal Group suggest a potential enhancement of oxygen-carrying capacity, with potential benefits for overall tissue oxygenation and systemic health. These results underscore the polyherbal tea mixture's potential as a functional beverage with hematopoietic effects, providing a natural approach to support blood health and oxygen delivery. The investigation into Packed Cell Volume (PCV) or Hematocrit (Hct) levels across experimental groups yielded insightful results. The Polyherbal Group demonstrated a significant impact on PCV or Hct levels compared to both the Negative Control Group and the Standard Tea Group, suggesting a potential influence on blood viscosity and overall cardiovascular health (Gomez *et al.,* 2023; Martinez & Rodriguez, 2021).

Summarizing the key findings, the Polyherbal Group exhibited a substantial increase in PCV or Hct levels, indicating a potential effect on blood volume and composition, in contrast to the limited impact observed in the Standard Tea Group and the Negative Control Group.

Interpreting these findings, the elevated PCV or Hct levels in the Polyherbal Group suggest a potential modulation of blood viscosity. The herbal components within the polyherbal tea mixture may contribute to this observed effect, potentially influencing erythropoiesis and fluid balance (Brown & Johnson, 2022). In contrast, the Standard Tea Group, although recognized for its general health benefits, did not exhibit a significant impact on PCV or Hct levels, emphasizing the specificity of the polyherbal tea mixture's effects on hematological parameters. These results underscore the polyherbal tea mixture's potential as a functional beverage with hematological effects, providing a natural approach to support cardiovascular health. The Mean Corpuscular Volume (MCV) levels across experimental groups revealed significant outcomes. The Polyherbal Group exhibited a noteworthy alteration in MCV levels, indicating a potential effect on red blood cell size. In contrast, the Negative Control Group and the Standard Tea Group did not show a comparable impact on MCV. Interpreting these findings, the altered MCV levels in the Polyherbal Group suggest a potential modulation of erythropoiesis, influencing the size of red blood cells. The herbal components within the polyherbal tea mixture may contribute to this observed effect, potentially affecting the maturation and size of red blood cells in the bone marrow (Brown & Johnson, 2022). In contrast, the Standard Tea Group, despite its recognized health benefits, did not exhibit a significant impact on MCV levels, emphasizing the specificity of the polyherbal tea mixture's effects on erythrocyte parameters. These results underscore the polyherbal tea mixture's potential as a functional beverage with hematological effects, providing a natural approach to support red blood cell dynamics. In conclusion, the study highlights the potential effects of the polyherbal tea mixture on red blood cell size, as evidenced by altered MCV levels.

The Mean Corpuscular Hemoglobin (MCH) levels across experimental groups revealed noteworthy findings. The Polyherbal Group demonstrated a significant impact on MCH levels compared to both the Negative Control Group and the Standard Tea Group, indicating a potential influence on the amount of hemoglobin per red blood cell (Gomez *et al*., 2023; Martinez & Rodriguez, 2021). The herbal components within the polyherbal tea mixture may contribute to this observed effect, potentially influencing the synthesis of hemoglobin during erythropoiesis in the bone marrow (Brown & Johnson, 2022). Conversely, the Standard Tea Group, despite its recognized health benefits, did not exhibit a significant impact on MCH levels, emphasizing the specificity of the polyherbal tea mixture's effects on hemoglobin-related parameters.

The Mean Corpuscular Hemoglobin Concentration (MCHC) levels across experimental groups revealed significant outcomes. The Polyherbal Group exhibited a notable impact on MCHC levels compared to both the Negative Control Group and the Standard Tea Group, suggesting a potential influence on hemoglobin concentration within red blood cells (Gomez *et al*., 2023; Martinez & Rodriguez, 2021).

Interpreting these findings, the altered MCHC levels in the Polyherbal Group suggest a potential enhancement of hemoglobin concentration within individual red blood cells. The herbal components within the polyherbal tea mixture may contribute to this observed effect, potentially influencing hemoglobin synthesis or stability during erythropoiesis in the bone marrow (Brown & Johnson, 2022). Conversely, the Standard Tea Group, despite its recognized health benefits, did not exhibit a significant impact on MCHC levels, emphasizing the specificity of the polyherbal tea mixture's effects on hemoglobin-related parameters. This has potential implications for oxygen-carrying capacity, as hemoglobin concentration is crucial for the efficient transport of oxygen in the blood. These results underscore the polyherbal tea mixture's potential as a functional beverage with hematological effects, providing a natural approach to support hemoglobin dynamics. The Polyherbal Group exhibited a substantial impact on PLT levels compared to both the Negative Control Group and the Standard Tea Group, suggesting a potential influence on platelet count and function (Gomez et al., 2023; Martinez & Rodriguez, 2021). The Polyherbal Group displayed a significant alteration in PLT levels, indicating a potential modulation of platelet count. In contrast, the Negative Control Group and the Standard Tea Group did not show a comparable impact on PLT. The herbal components within the polyherbal tea mixture may contribute to this observed effect, potentially affecting the regulatory mechanisms involved in platelet dynamics (Brown & Johnson, 2022). Conversely, the Standard Tea Group, despite its recognized health benefits, did not exhibit a significant impact on PLT levels, emphasizing the specificity of the polyherbal tea mixture's effects on platelet-related parameters. These results underscore the polyherbal tea mixture's potential as a functional beverage with hematological effects, providing a natural approach to support platelet dynamics. The investigation into HDL levels across experimental groups revealed noteworthy variations. The Polyherbal Group and Standard Tea Group exhibited significantly higher HDL levels compared to other groups, with the Polyherbal Group demonstrating the most substantial increase (Smith *et al.,* 2021; Johnson & Martinez, 2020). Conversely, the Negative Control Group had considerably lower HDL levels. These findings underscore the potential impact of the polyherbal tea mixture and standard tea on modulating HDL cholesterol in the context of the experimental conditions. The elevated HDL levels observed in the Polyherbal Group and Standard Tea Group align with established literature associating high HDL cholesterol with a reduced risk of cardiovascular diseases (Jones, 2019). HDL is recognized for its role in reverse cholesterol transport, removing excess cholesterol from peripheral tissues and transporting it to the liver for excretion. The observed increase in HDL levels in these groups may imply a positive effect on lipid metabolism and cardiovascular health. Additionally, the significant decrease in HDL levels in the Negative Control Group further emphasizes the potential of the polyherbal tea mixture and standard tea in maintaining or enhancing HDL cholesterol concentrations. Elevated HDL levels are generally considered favorable due to their association with a lower risk of atherosclerosis and cardiovascular events (Smith & Johnson, 2020). The observed increase in HDL levels in the Polyherbal Group suggests a potential protective effect against cardiovascular diseases, which is particularly significant given the rising global burden of cardiovascular disorders.

The Triglyceride (TG) levels across experimental groups yielded intriguing insights. Notably, the Normal Control Group, Sorghum Group, Polyherbal Group, and Standard Tea Group displayed lower TG levels, indicating potential lipid-lowering effects. Conversely, the Negative Control Group exhibited higher TG levels, underscoring the efficacy of the polyherbal tea mixture and standard tea in mitigating elevated triglyceride concentrations (Smith et al., 2021; Rodriguez & Martinez, 2020). The observed decrease in TG levels in the Polyherbal Group aligns with established literature linking certain herbal components to lipid-modulating properties. This suggests a potential role of the polyherbal tea mixture in improving lipid metabolism and reducing triglyceride levels, contributing to cardiovascular health. The Negative Control Group's elevated TG levels further emphasize the significance of the polyherbal tea mixture and standard tea in counteracting abnormal lipid profiles (Brown, 2022).

The implications of these findings are substantial, as elevated triglyceride levels are associated with an increased risk of cardiovascular diseases (Smith & Johnson, 2020). These results underscore the potential of the polyherbal tea mixture as a functional food with lipid-modulating properties, providing a holistic approach to managing triglyceride levels and reducing cardiovascular risk factors (Jones, 2019). The Very Low-Density Lipoprotein (VLDL) levels across experimental groups yielded noteworthy insights, with significance levels set at $p < 0.05$. The Avocado Group displayed a significant decrease in VLDL levels compared to the Negative Control Group, indicating a potential lipid-modulating effect (Gomez *et al.*, 2021). The Sorghum Group and Polyherbal Group also exhibited lower VLDL levels, suggesting the influence of these interventions on lipid metabolism.

The observed reduction in VLDL levels aligns with existing literature highlighting the cardiovascular benefits of avocado consumption (Rodriguez & Martinez, 2019). Avocado is known for its monounsaturated fats and other bioactive compounds that contribute to lipid profile improvements. The decrease in VLDL levels in the Polyherbal and Sorghum Groups may suggest a collective impact of these interventions on lipid homeostasis, potentially lowering the risk of cardiovascular diseases (Brown, 2020).

The Low-Density Lipoprotein (LDL) levels across experimental groups revealed intriguing patterns. The Negative Control Group exhibited significantly elevated LDL levels compared to the Normal Control Group, indicating a potential dysregulation of lipid metabolism. However, the Polyherbal Group and Standard Tea Group displayed significantly lower LDL levels, suggesting a mitigating effect on LDL cholesterol (Smith *et al*., 2021; Rodriguez & Martinez, 2020).

Interpreting these findings, the marked increase in LDL levels in the Negative Control Group underscores the potential negative impact of the experimental conditions on lipid homeostasis. In contrast, the observed reduction in LDL levels in the Polyherbal and Standard Tea Groups aligns with existing literature associating certain herbal components with cholesterol-lowering effects. This suggests a potential role for the polyherbal tea mixture and standard tea in modulating LDL cholesterol and promoting cardiovascular health (Brown, 2022).

The implications of these findings are significant, given the established link between elevated LDL cholesterol and increased cardiovascular risk. The observed reduction in LDL levels in the Polyherbal Group and Standard Tea Group suggests a promising avenue for dietary interventions aimed at managing cholesterol levels. These results underscore the potential of the polyherbal tea mixture as a functional food with lipid-modulating properties, providing a holistic approach to reducing cardiovascular risk factors associated with elevated LDL cholesterol (Jones, 2019).

5. Conclusion

The findings underscore the multifaceted benefits of the polyherbal tea mixture, including anti-inflammatory, antioxidant, immunomodulatory, hematopoietic, and lipid-modulating properties. The study highlights the potential of this functional beverage as a natural approach to promoting overall health and mitigating risk factors associated with chronic diseases, such as inflammation, oxidative stress, and cardiovascular diseases.

Compliance with ethical standards

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