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Evaluation of Blood Biochemistry and Hematological Profiles in Rats on a Processed Sweet Potato Diet

Kondeti Haritha Pavani[1], G. S. Hiremath[2], Y Anveshi Dhananjaya[3*], V. Devi[4], Venkat Gangadhar Chougule[5], M Naveen Kumar[6], Touseef Begum[7], Nilesh Pratapsing Babre[8]

[1]Department of Pharmaceutical Analysis, Chebrolu Hanumaiah Institute of Pharmaceutical Sciences, Guntur, A.P, India Pin- 522019.
[2]Department of Pharmacology, BVVS Hanagal Shri Kumareshwar College of Pharmacy Bagalkot, Karnataka, India Pin: 587101.
[3]Department of Pharmacology, Avanthi Institute of Pharmaceutical Sciences,Vizianagaram, AP, India Pin- 531162.
[4]Department of Pharmacology, Avanthi institute of pharmaceutical sciences,vizianagaram, AP, India Pin- 531162.
[5]Department of Pharmaceutical Chemistry, ASPM's K T Patil College of Pharmacy, Osmanabad , Maharashtra , India Pin- 413501.
[6]Department of Pharmacology, Vaageswari College of Pharmacy, Thimmapur, Karimnagar, Telangana, India-505527.
[7]Department of Pharmaceutical Sciences, Ibn Sina National College for Medical Studies, P.O. Box 31906, Jeddah 21418, Kingdom of Saudi Arabia.
[8]Department of Pharmacology, Oriental College of Pharmacy, Sanpada Sector 2 Plot no. 3, 4, 5 Behind Sanpada railway Station, Thane Pin code:-400705 Maharashtra.

Corresponding Author
Y Anveshi Dhananjaya[3*],
Department of Pharmacology, Avanthi Institute of Pharmaceutical Sciences,Vizianagaram, AP, India Pin- 531162.

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ABSTRACT:

Sweet potatoes (*Ipomoea batatas*) are nutrient-dense root vegetables renowned for their high content of essential vitamins, minerals, fiber, and antioxidants. This study explores the health and therapeutic benefits of sweet potatoes, emphasizing their potential for enhancing overall health, regulating blood sugar levels, supporting immune function, and promoting cardiovascular health. The anti-inflammatory and antioxidant properties of sweet potatoes make them a valuable dietary component for preventing and managing chronic diseases such as diabetes, heart disease, and cancer. To investigate these benefits, we incorporated sweet potatoes into the diet of experimental Wistar rats, enriching their feed with boiled and grilled sweet potatoes. The rats' hematological parameters were closely monitored to assess the impact of the fortified diet. Our findings indicated significant improvements in red blood cell indices and white blood cell counts, suggesting enhanced oxygen-carrying capacity and immune response. Additionally, the study provided insights into the metabolic and immunomodulatory effects of sweet potatoes, highlighting their potential for therapeutic applications. The results demonstrated the importance of sweet potatoes as a functional food with significant health benefits. By providing a comprehensive understanding of their impact on health, this research supports the inclusion of sweet potatoes in both human diets and scientific studies aimed at improving health outcomes and disease prevention.

Keywords: Sweet Potato, *Ipomoea batatas,* Haematological Parameters, Nutritional Benefits, Therapeutic Potential

INTRODUCTION

Sweet potato (*Ipomoea batatas*) is a versatile and nutrient-dense root vegetable that offers a myriad of health and therapeutic benefits. Native to Central and South America, it has become a staple food in many cultures due to its rich nutritional profile and potential health advantages. This essay explores the various health benefits of sweet potato, its therapeutic potential, and the rationale behind incorporating it into the diet of experimental rats (Islam, 2006, Liu et al., 2024, Chen et al., 2023, Bodjrenou et al., 2023, Yan et al., 2022, Nguyen et al., 2021).

Sweet potatoes are renowned for their high content of essential nutrients, including vitamins, minerals, fiber, and antioxidants. They are particularly rich in vitamin A, primarily in the form of beta-carotene, which is crucial for maintaining healthy vision, skin, and immune function. Additionally, sweet potatoes provide substantial amounts of vitamin C, vitamin B6, manganese, potassium, and dietary fiber. This combination of nutrients makes sweet potatoes a powerful food for supporting overall health (Mathura, 2023, Dewi et al., 2023, Mattoo et al., 2022, Makori et al., 2022, Jiang et al., 2022). One of the standout features of sweet potatoes is their high antioxidant content. Antioxidants are compounds that help neutralize free radicals in the body, thereby reducing oxidative stress and inflammation. The beta-carotene in sweet potatoes is a potent antioxidant that not only supports immune function but also promotes skin health and may reduce the risk of certain cancers. Anthocyanins, another type of antioxidant found in purple sweet potatoes, have been shown to possess anti-inflammatory and anti-carcinogenic properties (Nguyen et al., 2021, Habinshuti et al., 2020).

The high fiber content in sweet potatoes is beneficial for digestive health. Dietary fiber aids in promoting regular bowel movements, preventing constipation, and maintaining a healthy digestive tract. Additionally, the fiber in sweet potatoes serves as a prebiotic, feeding the beneficial bacteria in the gut and supporting a balanced microbiome. A healthy gut microbiome is linked to improved digestion, enhanced immune function, and better overall health (Liu et al., 2024, Yang et al., 2023, Chen et al., 2023, Castañeda et al., 2023, Arisanti et al., 2023, Makori et al., 2022). Despite their natural sweetness, sweet potatoes have a relatively low glycemic index (GI), which means they have a slower, more stable impact on blood sugar levels. This makes them a suitable carbohydrate source for individuals with diabetes or those looking to manage their blood sugar levels. The fiber in sweet potatoes also helps slow down the absorption of sugars, further contributing to blood sugar regulation (Luo et al., 2021, Ooi and Loke, 2013, Ooi and Loke, 2012, Barnes and Sanders, 2012). The high levels of vitamins A and C in sweet potatoes play a crucial role in supporting the immune system. Vitamin A helps maintain the integrity of mucous membranes in the gut and respiratory system, which act as barriers against infections. Vitamin C, on the other hand, stimulates the production of white blood cells and enhances their function, helping the body fight off pathogens (Habinshuti et al., 2020, Ssamula et al., 2019, Ambika and Nair, 2019). Sweet potatoes contribute to cardiovascular health in several ways. The potassium content helps regulate blood pressure by counteracting the effects of sodium and maintaining fluid balance in the body. Additionally, the fiber and antioxidants in sweet potatoes can help reduce cholesterol levels and prevent oxidative damage to the heart and blood vessels. Consuming sweet potatoes as part of a balanced diet may thus lower the risk of heart disease (Dewi et al., 2023, Castañeda et al., 2023, Yang et al., 2022, Ambika and Nair, 2019, Tanaka et al., 2017, Bovell-Benjamin, 2007, Thibodeau et al., 2002). Chronic inflammation is a key factor in the development of many diseases, including heart disease, diabetes, and cancer. Sweet potatoes contain a variety of anti-inflammatory compounds, such as beta-carotene, vitamin C, and anthocyanins, which help reduce inflammation in the body. Regular consumption of sweet potatoes can help mitigate the effects of chronic inflammation and support overall health.

Beyond their general health benefits, sweet potatoes also show promise in therapeutic applications. For instance, the antioxidant and anti-inflammatory properties of sweet potatoes have been investigated for their potential in cancer prevention and treatment. Studies have shown that compounds in sweet potatoes can inhibit the growth of cancer cells and induce apoptosis (programmed cell death) in various cancer cell lines (Chen et al., 2023, Castañeda et al., 2023). In addition, sweet potatoes have been explored for their potential benefits in managing diabetes. The fiber and low GI of sweet potatoes can help regulate blood sugar levels and improve insulin sensitivity. Some studies suggest that the compounds in sweet potatoes may also help protect against diabetic complications, such as neuropathy and retinopathy.

Incorporating sweet potato into the diet of experimental rats can provide valuable insights into its health benefits and potential therapeutic applications. Rats are commonly used in biomedical research due to their physiological and genetic similarities to humans. By studying the effects of sweet potato supplementation in rats, researchers can gain a better understanding of its impact on various health parameters and explore its potential benefits for human health. Adding sweet potato to rat chow enhances the nutritional quality of the diet, providing rats with essential vitamins, minerals, and antioxidants. This can help improve their overall health and well-being, making them better models for studying human diseases and health conditions (Chen et al., 2023, Castañeda et al., 2023, Bodjrenou et al., 2023, Arisanti et al., 2023). The high vitamin A content in sweet potatoes, for example, can support vision and immune function in rats, just as it does in humans. Researching the antioxidant and anti-inflammatory effects of sweet potato in rats can provide insights into its potential for preventing and treating oxidative stress and inflammation-related conditions. This is particularly relevant for studying diseases such as cancer, cardiovascular disease, and diabetes. By observing the effects of sweet potato supplementation on markers of oxidative stress and inflammation in rats, researchers can gather evidence to support its use in human health. Investigating the impact of sweet potato on blood sugar regulation and metabolic health in rats can help identify its potential benefits for managing diabetes and metabolic syndrome. The fiber content and low GI of sweet potatoes make them an interesting subject for studying their effects on insulin sensitivity, glucose metabolism, and overall metabolic health. Findings from such studies can inform dietary recommendations and interventions for individuals with diabetes or those at risk of developing the condition.

Studying the effects of sweet potato on immune function and disease resistance in rats can shed light on its potential for enhancing immune health in humans. By examining changes in white blood cell counts, immune responses, and disease resistance in rats fed with sweet potato-enriched diets, researchers can gather valuable data on its immunomodulatory properties. This can lead to a better understanding of how sweet potatoes can support immune health and potentially prevent infections and diseases. In conclusion, sweet potatoes offer a wide range of health and therapeutic benefits due to their rich nutritional profile, antioxidant properties, and potential for regulating blood sugar and supporting immune function. Incorporating sweet potato into the diet of experimental rats provides a valuable model for studying its effects on various health parameters and exploring its potential applications in human health. The findings from such research can inform dietary recommendations and interventions, contributing to the promotion of overall health and well-being (Dewi et al., 2023, Ambika and Nair, 2019, Tanumihardjo et al., 2017, Willcox and Willcox, 2014, Timson, 2014, Moona et al., 2014, Barnes and Sanders, 2012, Suksomboon et al., 2011, Thibodeau et al., 2002). Considering all the literature review and facts, this present study was designed to evaluate the potential impact of cooked, boiled, and grilled sweet potato on the blood biochemistry including the haematological parameters of Wistar rats.

MATERIAL AND METHODS

Sample Collection and Identification

We sourced the sweet potato for our study from a local market in Ambala, Haryana, India. To ensure proper identification, a botanist from the Department of Botany in Haryana authenticated the sample. We then deposited a voucher specimen in the herbarium of the Department of Biochemistry at the University, where it was assigned the number MKSP_OT567_335-71M.

Processing of Sample

The sweet potatoes were thoroughly washed and peeled to remove any dirt and impurities. After peeling, we sliced the sweet potatoes and dried them at room temperature for seven days. Once dried, the sweet potato slices were divided into three portions for further processing.

Cooked Sweet Potato

The first portion of the sweet potato was preboiled for 45 minutes in a pot containing only water. After boiling, we separated the skin manually. The cooked sweet potato was subsequently dried at room temperature. Once dried, it was pulverized using the manual grinding machine to obtain a fine powder. This powdered cooked sweet potato was stored in a well-labelled airtight plastic container until it was needed for the study.

Grilled Sweet Potato

The second portion of the sweet potato was grilled on a frying pan using a gas stove. After grilling, we separated the skin from the potatoes and dried. The grilled dried sweet potato was then pulverized into a fine powder using the same grinding machine. This powdered grilled sweet potato was stored in a well-labelled airtight plastic container until it was needed for the study.

Composition of the Rat Feed

The standard rat feed used in this study was a product of Pet Industries, purchased from a feed dealer in New Delhi. The ingredients used in the formulation of this feed included grains, cereals, vegetable protein meals, vitamins, minerals, essential amino acids, anti-toxins, and enzymes. The composition of the feed was as follows: Protein: 18%, Fiber: 9%, Ash: 12%, Oil: 8%, Calcium: 1%, Phosphorus: 1%. To prepare the fortified feed, we incorporated processed grilled and cooked sweet potato into the standard feed in specific ratios. Using an analytical weighing balance, we measured the feed and sweet potato accurately. For the grilled sweet potato mixture, we added 50 grams of grilled sweet potato to 100 grams of standard feed. Similarly, for the cooked sweet potato mixture, we added 50 grams of cooked sweet potato to 100 grams of standard feed. These formulations were repeated until we had enough feed to last for a period of one month (Vogel, 2007).

Study Design

This study aimed to evaluate the blood biochemistry and haematological indices of experimental rats fed with rat chow fortified with processed sweet potato. Eighteen adults male Wistar rats were used and randomly divided into three groups, each containing six rats. Group 1, serving as the control group, was fed standard rat chow diet, while Group 2 and 3, the experimental groups, were fed rat chow fortified diet with processed sweet potato (Boiled and grilled respectively). The standard rat chow was purchased from Pet Industries in New Delhi and comprised grains, cereals, vegetable protein meals, vitamins, minerals, essential amino acids, anti-toxins, and enzymes. To prepare the fortified diet, 50 grams of grilled sweet potato were added to 100 grams of standard feed for one portion, and 50 grams of cooked sweet potato were added to 100 grams of standard feed for another portion. These mixtures were stored in well-labelled airtight plastic containers. The feeding trial lasted for six weeks, during which the rats were housed in individual cages under standard laboratory conditions with a 12-hour light/dark cycle. They had free access to food and water throughout the study, and their body weights were recorded weekly. At the end of the feeding period, blood samples were collected via tail vain puncture. The collected blood samples were analysed for various haematological indices, including red blood cell (RBC) count, white blood cell (WBC) count, haemoglobin (Hb) concentration, haematocrit (HCT), platelet count, and differential WBC count. The data obtained were analysed using statistical software, with comparisons made between the control and experimental groups using the one-way ANOVA with post hoc Turkey test. A p-value of less than 0.05 was considered statistically significant. This study design ensured a controlled comparison between the effects of standard rat chow and sweet potato-fortified rat chow on the haematological indices of the rats (Vogel, 2007).

Feeding of the Experimental Animals

The experimental rats were provided with the specific feed prepared for their respective groups over a period of six weeks. At the conclusion of this feeding period, the rats were fasted and anesthetized using chloroform. Blood samples were then collected via tail vein puncture technique and stored in EDTA-coated bottles for subsequent haematological analysis. Following the blood collection, the carcasses were disposed of responsibly by burying them (Vogel, 2007).

Haematological Analysis

The haematological parameters of the collected blood samples were analysed using an automated haematology analyser (Mindray BC-5300). This comprehensive analysis included a wide range of blood indices to provide a detailed assessment of the rats' haematological health. The specific parameters measured were (Rifai, 2017, Emanuel, 2023):

- Haemoglobin (HGB): The concentration of haemoglobin in the blood, indicating the blood's oxygen-carrying capacity.
- Packed Cell Volume (PCV) or Haematocrit (HCT): The proportion of blood volume occupied by red blood cells, reflecting the overall blood cell mass.
- Red Blood Cells (RBC): The count of red blood cells, which are responsible for transporting oxygen from the lungs to the rest of the body.
- Platelets (PLT): The count of platelets, which play a crucial role in blood clotting and wound healing.
- Mean Corpuscular Volume (MCV): The average volume of a single red blood cell, providing information on cell size.
- Mean Corpuscular Haemoglobin (MCH): The average amount of haemoglobin per red blood cell, indicating how much oxygen each cell can carry.
- Mean Corpuscular Hemoglobin Concentration (MCHC): The average concentration of hemoglobin in a given volume of packed red blood cells.
- White Blood Cells (WBC): The count of white blood cells, which are key components of the immune system.
- Neutrophils (NEUT): A type of white blood cell involved in the immediate response to infection.
- Lymphocytes (LYMPH): White blood cells that are part of the adaptive immune system, including T cells and B cells.
- Monocytes (MON): White blood cells that differentiate into macrophages and dendritic cells to help in the immune response.
- Eosinophils (EOS): White blood cells involved in combating multicellular parasites and certain infections.
- Basophils (BAS): The least common type of white blood cell, involved in allergic reactions and inflammatory responses.

These haematological parameters provided a comprehensive overview of the health status and immune function of the rats, allowing us to assess the effects of the sweet potato-fortified diet on their haematological profile

Statistical analysis

The data collected from the haematological analyses were processed using GraphPad Prism statistical software to identify any significant differences between the control and experimental groups. Haematological data for each rat were systematically organized and entered into the statistical software for analysis. For each haematological parameter, we calculated the mean and standard deviation for both the control and experimental groups to provide a summary of the data. We employed the one way ANOVA test followed by post hoc Turkey test to compare the mean values of each haematological parameter among the groups. This test helped determine if the observed differences were statistically significant. A p-value of less than 0.05 was set as the threshold for statistical significance. Differences with p-values below this threshold were considered statistically significant, indicating a likely impact of the sweet potato-fortified diet.

RESULTS AND DISCUSSIONS

The haematological parameters HGB, PCV, and RBC showed significant variations across the different groups. The normal control group had HGB levels of 12.86±0.87 g/dl, PCV of 37.89±0.77%, and RBC of 7.58±0.98 g/dl. The group fed with boiled sweet potato (Group 1) exhibited slightly higher HGB (13.51±0.91 g/dl), PCV (40.34±1.01%), and RBC (7.86±0.99 g/dl) levels, indicating a potential enhancement in the oxygen-carrying capacity and overall red cell mass due to the fortified diet. Similarly, the group fed with grilled sweet potato (Group 2) showed increased values in HGB (13.26±0.72 g/dl), PCV (39.64±1.02%), and RBC (7.64±0.99 g/dl), although the increase was less pronounced compared to the boiled sweet potato group. Both fortified diets positively impacted these parameters, suggesting that sweet potato fortification, particularly boiled sweet potato, might improve haematological health by increasing the concentration of red blood cells and haemoglobin.

Table 1. Impact of sweet potato supplemented diet on various haematological parameters (HGB, PCV, RBC, and PLT) in Wistar rats, represented as mean ± SD

Groups	**HGB (g/dl)**	**PCV (%)**	**RBC (g/dl)**
Normal control	12.86±0.87	37.89±0.77	7.58±0.98
Group 1 (Boiled)	13.51±0.91	40.34±1.01	7.86±0.99
Group 2 (Grilled)	13.26±0.72	39.64±1.02	7.64±0.99

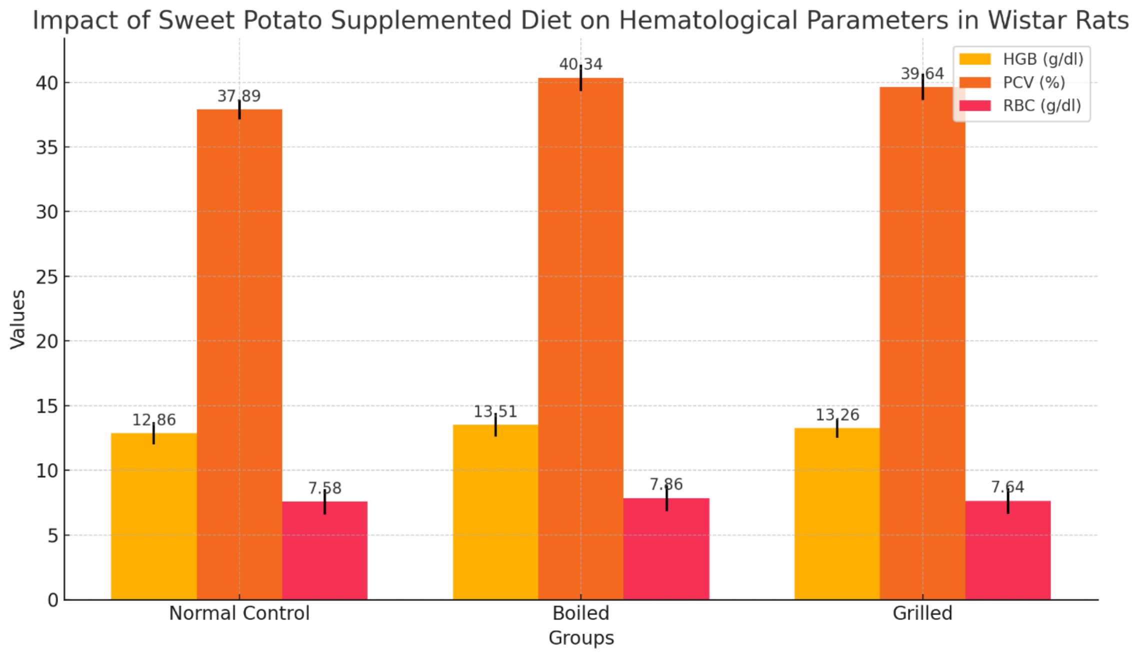

Figure 1. Impact of sweet potato supplemented diet on various haematological parameters including HGB, PCV, RBC, and PLT

The normal control group had a PLT count of 836.67±29.66 x10^9/L, MCV of 58.86±12.33 fl, MCH of 21.75±2.12 pg, and MCHC of 28.86±4.17 g/dl. Group 1 (Boiled) showed a decrease in PLT (720.44±69.66 x10^9/L) but slight increases in MCV (59.75±19.55 fl) and MCHC (35.65±4.33 g/dl), with MCH remaining relatively stable (21.65±2.22 pg). Group 2 (Grilled) had similar trends, with a lower PLT count (704.37±33.35 x10^9/L) and increased MCV (59.45±17.72 fl), while the MCH and MCHC levels showed substantial variability, particularly with MCHC rising sharply to 107.91±18.31 g/dl. The reduction in PLT counts in both fortified groups could indicate a possible effect of sweet potato on platelet production or survival. The substantial increase in MCHC in Group 2 requires further investigation, as it could be an anomaly or a significant finding related to the grilled sweet potato diet.

Table 2. The effect of adding boiling and grilled sweet potatoes to feed supplemented with other nutrients on certain haematological parameters (PLT, MCV, MCH, and MCHC)

Groups	**PLT (x10d/L)**	**MCV (fl)**	**MCH (Pg)**	**MCHC (g/dl)**
Normal control	836.67±29.66	58.86±12.33	21.75±2.12	28.86±4.17
Group 1 (Boiled)	720.44±69.66	59.75±19.55	21.65±2.22	35.65±4.33
Group 2 (Grilled)	704.37±33.35	59.45±17.72	21.83±2.11	107.91±18.31

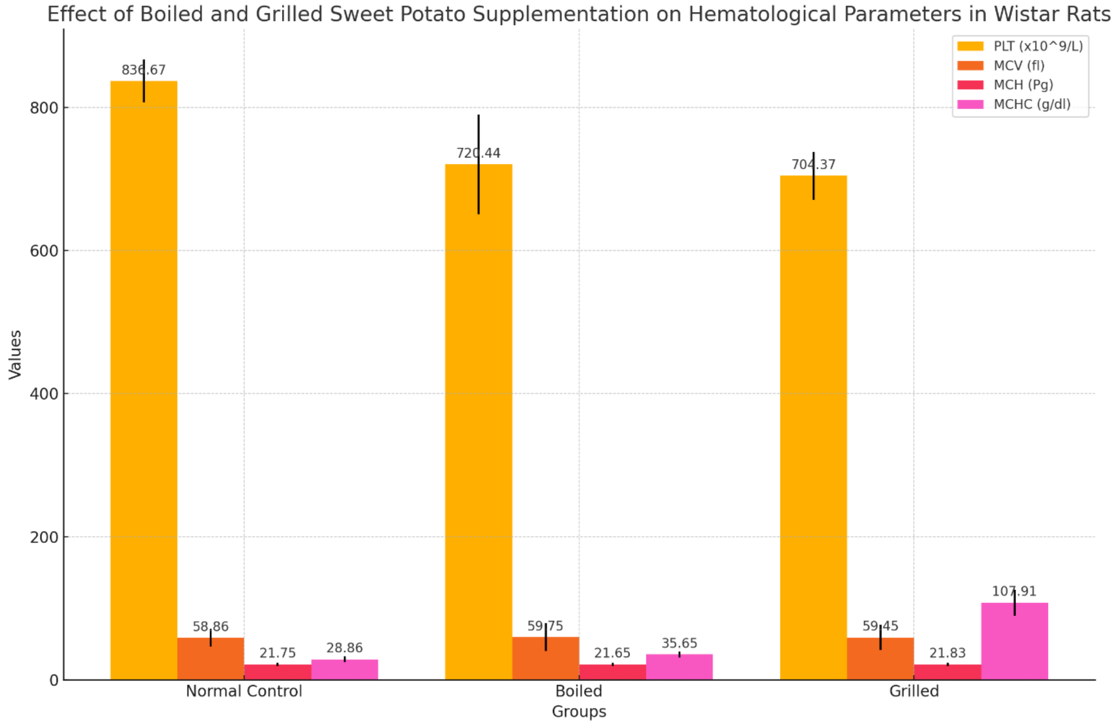

Figure 2. The effect of adding boiling and grilled sweet potatoes to feed supplemented with other nutrients on certain haematological parameters (PLT, MCV, MCH, and MCHC)

The WBC count in the normal control group was 8.40±0.98 x10^9/L, with neutrophils at 24.69±1.33%, lymphocytes at 77.75±3.76%, monocytes at 1.64±0.12%, eosinophils at 2.01±0.62%, and basophils at 2.02±0.27%. Group 1 (Boiled) showed a significant increase in WBC (14.48±2.87 x10^9/L) and neutrophils (40.82±4.32%), but a decrease in lymphocytes (62.24±3.46%) and monocytes (0.92±0.02%). Eosinophils and basophils were also affected, with eosinophils increasing to 4.01±0.99% and basophils decreasing to 0.89±0.09%. Group 2 (Grilled) had an even higher WBC count (15.49±2.21 x10^9/L) and changes in differentials, with lower neutrophils (20.35±2.35%), higher lymphocytes (81.61±4.22%), slightly higher monocytes (2.11±0.03%), lower eosinophils (1.01±0.98%), and lower basophils (0.76±0.01%).The increase in WBC counts in both fortified groups suggests an enhanced immune response, possibly due to the nutritional benefits of the sweet potato. However, the differential counts indicate different immune responses between the boiled and grilled sweet potato groups, with the boiled group showing a significant increase in neutrophils (suggesting a heightened innate immune response) and the grilled group showing a higher lymphocyte percentage (indicating an adaptive immune response).

Table 3. Impact of sweet potato-enriched diet on various white blood cell types and their subtypes (Neutrophil, Lymph, Mon, Eos, and Bas).

Groups	WBC (x10 d/L)	NEUT (%)	LYMPH (%)	MON (%)	EOS (%)	BAS (%)
Normal control	8.40±0.98	24.69±1.33	77.75±3.76	1.64±0.12	2.01±0.62	2.02±0.27
Group 1 (Boiled)	14.48±2.87	40.82±4.32	62.24±3.46	0.92±0.02	4.01±0.99	0.89±0.09
Group 2 (Grilled)	15.49±2.21	20.35±2.35	81.61±4.22	2.11±0.03	1.01±0.98	0.76±0.01

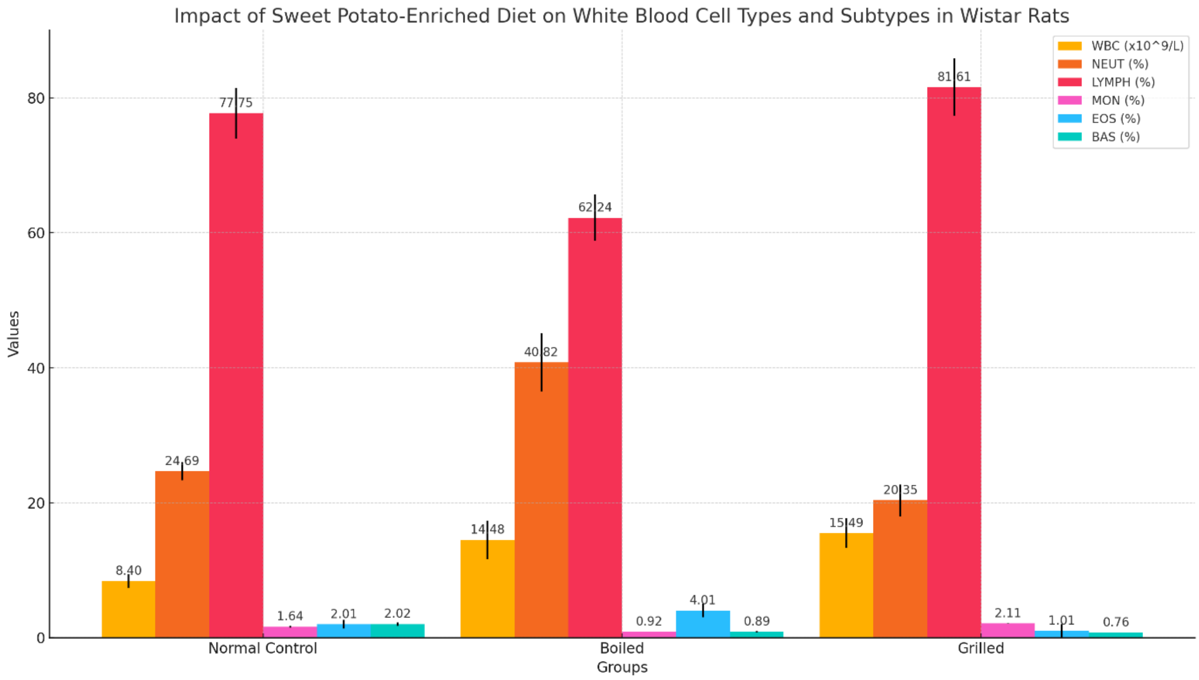

Figure 3. Impact of sweet potato-enriched diet on various white blood cell types and their subtypes (Neutrophil, Lymph, Mon, Eos, and Bas).

The fortified diets with boiled and grilled sweet potato positively impacted several haematological parameters, with notable improvements in red blood cell indices and white blood cell counts. The boiled sweet potato diet seemed to enhance the oxygen-carrying capacity and innate immune response, while the grilled sweet potato diet improved adaptive immune response. However, the sharp increase in MCHC for the grilled group and the decrease in platelet counts across both groups warrant further investigation to understand the underlying mechanisms and ensure the safety and efficacy of these fortified diets.

CONCLUSIONS

Sweet potatoes, with their rich nutritional profile, offer a myriad of health and therapeutic benefits. Their high content of vitamins, minerals, fiber, and antioxidants supports overall health, aids in blood sugar regulation, enhances immune function, and promotes cardiovascular health. The anti-inflammatory and antioxidant properties of sweet potatoes further indicated their potential in preventing and managing chronic diseases such as diabetes, heart disease, and cancer. Incorporating sweet potatoes into the diet of experimental rats not only enriches their nutritional intake but also provides a robust model for studying the root vegetable's health benefits and therapeutic potential. Research findings from such studies can translate into valuable insights for human health, guiding dietary recommendations and interventions aimed at enhancing health and preventing disease. The promising effects observed in animal models highlight sweet potatoes as a beneficial dietary component with significant implications for improving human health. Thus, sweet potatoes stand out as a versatile and health-promoting food, worthy of inclusion in both everyday diets and scientific research for their potential to contribute to a healthier lifestyle and better disease management**.**

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