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Effect of Aqueous Extracts of Some Indigenous Plants on Hematological Parameters, Hepatotoxicity and Antioxidant Status of Swiss Albino Rats Exposed to Cement Dust

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ABSTRACT

Exposure to cement dust can lead to respiratory problems, lung diseases, and even cancer. The study focuses on four plants: Telfaria occidentalis, Moringa oleifera, Zingiber officinale, and Hibiscus sabdariffa. These plants have been traditionally used for therapeutic purposes and are known for their potential health benefits. The study uses laboratory rats to assess the effects of these plants on hematological parameters and oxidative stress resulting from long-term exposure to cement dust. The results of the study show that the dietary supplements containing these plants have positive effects on hematological parameters, such as packed cell volume (PCV), red blood cell (RBC) count, and white blood cell (WBC) count. The extracts increase PCV levels, improve RBC production, and enhance immune system function. The study also finds that the supplements have antioxidant effects, as they increase the activity of antioxidant enzymes, such as catalase (CAT), superoxide dismutase (SOD), and reduced glutathione (GSH). Additionally, the supplements have positive effects on liver function markers, reducing the levels of alanine aminotransferase (ALT) and aspartate aminotransferase (AST). In conclusion, the study suggests that dietary supplements containing Telfaria occidentalis, Moringa oleifera, Zingiber officinale, and Hibiscus sabdariffa have shown potential for mitigating the negative effects of cement dust pollution on hematological parameters, oxidative stress, and liver function. Further research is needed to understand the protective mechanisms of these plants and develop interventions to protect against industrial contaminants like cement dust.

KEYWORDS: *Indigenous Plant; Cement Dust; Hepatoxicity; Antioxidant; Hematological*

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INTRODUCTION

The industrialized world presents complex challenges, including the harmful effects of climate dust on local ecosystems and human health. This issue is particularly concerning in the cement industry, which produces fine particulate matter containing substances like silicon dioxide, calcium oxide, magnesium magnesium oxide, aluminum oxide, and iron oxide (Kholodov *et al*., 2020). The importance of cement in the building industry cannot be overemphasized, but its by-product is one of the major source of air pollution for cement mill workers and the people living around the cement factory. Cement dust, a powder made of small grayish and whitish particles, is a significant source of pollution during the production phase of cement that affects both human well-being and the natural environment (Du *et al*., 2023; Tkaczewska, 2019). Cement dust exposure through inhalation can lead to respiratory problems and result in atrophic changes in the mucous of the nose and pharynx, chronic exfoliative bronchitis, and laryngitis, pharynx catarrh, and chronic rhinitis (Rahmani *et al*., 2018; Meo, 2004). It can lead to impaired lung functions, pneumoconiosis, chronic obstructive pulmonary disease, restrictive lung disease, lung, stomach, and colon cancer, and compromised structural integrity of cells and organs (Lestari *et al*., 2023; Leem, 2012). Exposure to cement dust can result in cancer, immune-related problems, allergies, and asthma. It also affects the natural environment by causing soil degradation, crop damage, and a decline in biodiversity near cement factories (Nkhama *et al*., 2022). This pollution is not limited to emerging nations, as developed countries like the United States and China also contribute to pollution.

Nigeria, with a growing population and need for infrastructure and housing, faces environmental and health issues due to the construction industry's expansion. To combat this problem, various strategies have been suggested, including the use of alternative materials, energy-efficient technologies, and pollution control measures. In Nigeria, the Standards Organization of Nigeria (SON) introduced a new standard to control dust emissions from climate factors in 2018.

Phytochemical methods have gained prominence as a means to mitigate the effects of cement dust pollution by neutralizing or absorbing hazardous substances within carbon dust through plants and their derivatives (Nowoświat & Dulak, 2020). To effectively address this challenge, the cement industry should embrace sustainable practices, implement pollution control measures, and explore progressive alternatives like phytochemical strategies. This research aims to investigate these effects, develop phytochemical strategies to ameliorate the effect, and suggest approaches to safeguard the health of people living near the cement industry.

Medicinal plants are considered to have therapeutic action, based on popular or scientific knowledge (Adedayo *et al*., 2023). Plants were among the first therapies that ancient humans employed to combat illnesses; since then, science has advanced these methods (Ajiboye *et al*., 2024; Chaachouay *et al*., 2022). This study explores four different plants, *Telfaria occidentalis*, *Moringa oleifera*, *Zingiber officinale*, and *Hibiscus sabdariffa*, which has been widely utilize for therapeutic purposes both traditionally and as conventional food supplements; for their effect on hematological parameters and oxidative stress resulting from long term exposure to pollution from cement dust in Swiss albino rats.

MATERIALS AND METHODS

Animal Procurement

Thirty (30) healthy Swiss albino rats purchased from the Nigeria Institute of Medical Research (NIMR) in Yaba, Lagos, were used in this study. Animals were handled according to the EU recommendations (Directive 2010/63/EU) for animal experiments, and were allowed to acclimatize at 25 °C ± 2 °C with a 12 h light/dark cycle, with access to water and standard pellets *ad libitum*. An ethical approval was obtained from the University of Lagos Research and Ethics Committee.

Plant Collection and Extraction

The botanical specimens, namely *Telfairia occidentalis* (Ugwu), *Hibiscus sabdariffa* (Zobo), *Moringa oleifera*, and *Zingiber officinale* (Ginger), were procured from the Oyingbo market situated in the bustling metropolis of Lagos. The plant samples were air-dried and grinded into finely texture powder and stored for further processing. This study used 250ml of distilled water to immerse 50g of finely ground plant material in a beaker. The plant samples were covered and allowed to steep for half an hour. The extract was then filtered out using a muslin cloth to separate it from any solid particles.

Experimental Design

A total of thirty Swiss albino rats, each weighing between 143.1 and 147.02 grams, were selected for this experiment. The rats were further divided into five experimental groups A - E, including the control group (Group A), with each group consisting of six rats. The control group receives 1ml of distilled water while group B, C, D and E received 1ml of the extract corresponding to 500 mg/kg aqueous extract of *Telfairia occidentalis* (Ugwu), *Hibiscus sabdariffa* (Zobo), *Moringa oleifera*, and *Zingiber officinale* (Ginger), respectively. Treatment was administered once daily for 4 weeks experimental period.

Biochemical Assays

All the animals were fasted 24h after the final treatment and euthanized via anesthesia. Blood samples were obtained by cardiac puncture into an EDTA bottle and were rapidly centrifuges at 3000 rpm at 4°C for 15 mins. The serum obtained was stored at -20°C and subsequently assayed for hepatic function parameters including Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT); and hematological parameters such as Packed Cell Volume (PCV), Red Blood Cell (RBC) concentration and White Blood Cell (WBC) count using the standard commercial kits obtained from Sigma, USA. The analysis were carried out following the guideline and instructions of the manufacturer. The antioxidant enzyme activities were also assayed according to previously established procedures: catalase activity (Sinha, 1972), superoxide dismutase (SOD) activity (Sun and Zigman, 1978), and reduced glutathione (GSH) activity (Tappel, 1978).

Data Analysis

Results of replicate readings were pooled and expressed as Mean ± SEM. One-way Anova was used to analyze the results, with $p<0.05$ as the accepted significant value.

RESULTS

The study reveals that nutritional supplements, particularly those containing Ugwu, Moringa, and Ginger, significantly increase packed cell volume (PCV) levels in laboratory rats (Table 1). These supplements can improve the overall health and well-being of the animals tested, potentially by improving purple blood cell production and circulation. The research also highlights a significant decrease in PCV ranges in rats fed with Zobo, emphasizing the importance of nutritional choices and their implications for hematological parameters. The study also provides insights into the effects of dietary supplements on white blood cell (WBC) and red blood cell (RBC) levels in laboratory animals (Table 1). The ginger extract supplement showed a notable increase in WBC levels, which is crucial for immune system defense mechanisms, disease resistance, and overall well-being. The study also found that animals treated with moringa also exhibited an increase in WBC levels, although the increase was relatively minor. The study also found that animals fed with *Telfairia occidentalis* (Ugwu) showed the most substantial increase in RBC levels, as RBCs are responsible for transporting oxygen throughout the body and are essential for energy production and overall health. The slight increase in RBC levels in animals consuming other dietary supplements suggests that different supplements may have varying effects on red blood cell production.

Table 1: The effects of food supplements on the Haematological parameters of normal Swiss albino rats.

	PVC (%)	WBC (MM^2)	RBC ($x10^{12-1}$)
Control	33.83 ± 3.25	6,258 ± 3.92	3.62 ± 0.44
Ugu	40.17 ± 5.32[a]	10,275 ± 4.26[a]	4.97 ± 0.60[a]
Moringa	36.33 ± 5.96[a]	7.608 ± 3.02[a]	3.87 ± 0.57[a]
Ginger	34.67 ± 2.26[a]	11,317 ± 2.66[a]	3.47 ± 0.48
Zobo	32.67 ± 4.50	6,400 ± 3.32	3.49 ± 0.45

Results presented as Mean ± SEM. a = P<0.05

The Moringa supplement appears to have the most notable impact on enhancing antioxidant enzyme activities in rats (Table 2). All the extract supplements show significant effects on CAT, and GSH levels compared to the control group. However, the SOD level was significantly increased in the moringa and ginger treatment, unlike the Ugwu and Zobo that show no distinct difference when compared to the control group.

Table 2: The Level of antioxidant enzymes of rats fed with food supplements.

	SOD	CAT	GSH
Control	36.21 ± 1.09	2.02 ± 0.13	0.07 ± 0.11
Ugu	37.26 ± 1.85	3.72 ± 0.29[a]	0.13 ± 0.23[a]
Moringa	42.35 ± 2.95[a]	4.31 ± 0.41[a]	0.28 ± 0.45[a]
Ginger	38.50 ± 2.60[a]	2.86 ± 0.61[a]	0.19 ± 0.81[a]
Zobo	28.12 ± 1.52	3.82 ± 0.18[a]	0.21 ± 0.35[a]

Results presented as Mean ± SEM. a = P<0.05

The study also highlights the effects of the extracts on liver function markers (Table 3) including alanine aminotransferase (AST) and alanine aminotransferase (ALT). Ginger had the most notable positive effects on liver health, as they are associated with lower AST and ALT levels compared to the control group. Moringa also shows some positive impact, while Zobo has the least impact on AST level compared to the control.

Table 3: The level of aspartate aminotransferase (AST) and Alanine aminotransferase (ALT) on rats fed with food supplement.

	AST	ALT
Control	11.67 ± 2.81	9.17 ± 1.47
Ugu	8.67 ± 2.36[a]	6.33 ± 0.82[a]
Moringa	7.67 ± 1.12[a]	6.09 ± 0.56[a]
Ginger	6.10 ± 1.74[a]	6.07 ± 0.10[a]
Zobo	8.74 ± 1.80[a]	7.50 ± 0.74 [a]

Results presented as Mean ± SEM. a = P<0.05

DISCUSSION

Considering cement dust as a poison, a mutagen, and a carcinogen for an animal (Akinola, 2008), chronic exposure to cement dust affects the health of humans negatively, leading to illnesses such as severe anemia, a decline in hemoglobin levels, and other hematologic abnormalities (Ahmad & Akhter, 2018). The free radical neutralizing abilities of Zingiber officinale may be the reason for the highest white blood cell (WBC) count seen in animals fed the plant extract, which is consistent with research conducted by Rhode *et al*., (2007). The highest

quantification of Erythrocytes (RBC) count was recorded in rats supplemented with Telfaria occidentalis and this is in agreement with research conducted by Nwanna and Oboh (2007) on the antioxidant properties of polyphenol extract from Telfaria Occidentalis.

The enzyme superoxide dismutase (SOD) is often encountered, and it repairs the cells and minimizes damage caused by the body's dominant free radical superoxide anion (Oyeleye *et al*., 2019). Superoxide dismutase is found in all other cells that metabolize oxygen (Gregory et., al, 1974). The superoxide dismutase is also an antitoxin to O_{2-} superoxide anion. As observed by McCord *et al*. in 1974, exogenous SOD may have an anti-inflammatory effect that protects against oxidized hyaluronate depolymerized by free radicals (Salin and McCord, 1975)

One of the major factors is that superoxide dismutase also works as a pro-oxidant in that it facilitates speeding of superoxide radical dismutation into H_2O_2, which then must be removed by catalysts such as selenium and copper in comparison with the control group, all the extracts, apart from Zobo, significantly enhanced SOD activity in the entire group. However, moringa possesses the highest antioxidant capacity associated with its high levels of SOD. Catalase is a universal substance that decomposes hydrogen peroxide into water and oxygen when living beings are exposed to oxygen. Catalase is one of the highest-turnover enzymes. It converts at least millions of molecules of hydrogen peroxide to water and oxygen each second (Adedayo *et al*., 2023; Boon, *et al*., 2007)

A tetrameric hemeprotein called catalase is reduced from H_2O_2 to its substrate at its active site (Chelikan *et al*, 2004). It is considered that there has been a rise following an increase in oxidative stress, possibly damaging the liver and leading to enzyme leakage into the blood through the administration of the extracts. This is why the enzyme increased in the liver and decreased in the blood.

Reduced glutathione (GSH), also referred to as the most significant biomolecule guarding against chemical-induced cytotoxicity. In conjunction with hydrogen peroxide reduction, GSH will remove reactive intermediates or direct free radical quenching. This includes the detoxification of toxic, reactive metabolites (Azzi, 2007). The study revealed no significant reduction of (GSH) in the rats whose food is supplemented with extracts. This shows that the extracts were acting to induce the concentration of GSH levels in the plasma with the highest GSH level observed in the Moringa fed rats. When GSH levels are low, ROS and oxidative stress are generated much faster. It results in a chain of effects that ultimately damages the structure and function of cell's and organelle's membranes (De Leve *et al*., 1996). Since the high GSH could be leading to an elevated glutathione redox cycle, Moringa can be working against protein oxidation. Also, they directly neutralize the reactive intermediate species caused by exposure to cells, like chemical carcinogenesis, and detoxify ROS (Traber & Studies establish that the most sensitive enzymes used in the diagnosis of hepatic disease include AST and ALT (Adeoye & Oyedapo, 2004). These can enter the bloodstream from injured liver cells and serve as indicators of cell damage.

Apart from being present in the liver, aspartate enzymes exist in most other tissues, such as the heart (Burger *et al*., 2005). The rats fed with Moringa and the mixture had lower plasma concentrations of ALT and AST than the controls, whereas the rats that were administered with Ugwu, Ginger, and Zobo recorded significantly higher values for this parameter. Since these groups protect the liver from free radical-related damages, the high decline in AST and ALT levels in rats fed Moringa and mixture might be a manifestation of their antioxidant potential.

CONCLUSION

This study explores the potential of dietary supplements to mitigate the negative effects of exposure to cement dust on hematological parameters, hepatic function markers and oxidative stress enzymes. The research, involving experimental rats exposed to cement dust, found that *Telfairia occidentalis*, *Zingiber officinale*, *Moringa oleifera*, and *Hibiscus sabdariffa* extracts used as a dietary supplement, significantly improved enzyme levels associated with

oxidative stress while reducing liver enzyme levels. This suggests that the study plants could serve as a protective shield against hematological disruptions caused by cement dust exposure. The findings underscore the importance of dietary supplementation in counteracting environmental pollutants and the need for further research into the protective mechanisms of the study plants. This could lead to innovative interventions to protect both humans and the environment from industrial contaminants like cement dust.

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