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Short-Term Effects of Ethanolic Garlic and Ginger Extracts on Haematological and Biochemical Profiles of Wistar Rats

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ABSTRACT

Garlic (*Allium sativum*) and ginger (*Zingiber officinale*) are widely consumed spices with recognized medicinal and nutritional applications. This study evaluated the effects of short-term oral administration of garlic and ginger extracts on selected haematological and biochemical parameters in Wistar rats. Eighteen female Wistar rats weighing approximately 150 g were used for the study and divided into control and treatment groups. The treatment groups received 100 mg/kg and 200 mg/kg body weight of garlic or ginger extracts orally for 10 days, while control animals received normal saline throughout the experiment. Blood samples were collected following extract administration and analysed for selected haematological and biochemical parameters. The results were analyzed using one-way ANOVA and significant difference set at $P < 0.05$. Garlic administration at 100 mg/kg significantly reduced packed cell volume (PCV), whereas 200 mg/kg had no significant effect. In contrast, 200 mg/kg ginger significantly increased PCV and haemoglobin concentration. Both garlic and ginger significantly reduced total white blood cell and neutrophil counts, while lymphocyte and monocyte responses varied according to extract type and dose. Garlic and ginger also significantly affected platelet counts, mean corpuscular volume and mean corpuscular haemoglobin. Biochemical analysis showed that lower-dose treatments generally reduced alanine aminotransferase (ALT), whereas 200 mg/kg ginger significantly increased ALT. Both extracts significantly reduced total and conjugated bilirubin levels, while total protein increased at 100 mg/kg and decreased at 200 mg/kg for both extracts. The findings demonstrate that short-term administration of the extracts produces dose-dependent and extract-specific alterations in haematological and biochemical parameters.

Keywords: Garlic, Ginger, Biochemical, Haematological, Wistar Rats

INTRODUCTION

Spices have been used for thousands of years for medicinal practices and culinary arts globally, and their applications have extended into functional nutrition, where their constituent bioactive compounds are increasingly recognized for their therapeutic potential against chronic diseases (Mojica et al., 2026).

Garlic (Allium sativum) and ginger (Zingiber officinale) have been used individually or together as therapeutic as well as prophylactic plants due to their ability to maintain or promote normal human health. In addition to their therapeutic applications, pulverized garlic and ginger are used for culinary purposes to improve taste and they have been used by locals to replenish blood loss (Ahmad et al., 2024). Both spices have been found to suppress fat accumulation in broiler chicken, without affecting other carcass traits, lipid and red blood cell indices (Idoko et al., 2019).

Studies have shown that spices like nutmeg, scent leaf, and turmeric impact the haematological parameters that determine the pathological and physiological state of animals (Ukoha et al., 2024). Blood analysis provides critical information about the pathological and physiological state of animals.

Studies have shown that daily administration of some spices like ginger, garlic, or turmeric for 21 days could either exert hepatoprotective effect or hepatotoxic effect on experimental animals; while garlic was reported to exert hepatoprotective effect by reducing studied biochemical parameters, ginger and turmeric increased these parameters and were reported to be hepatotoxic (Ahmad et al., 2023; Ahmad et al., 2024).

We observed that most users of garlic and ginger spices in Lokoja Metropolis only consume them for a few days for their medicinal or culinary purposes; as a result, it became pertinent to conduct the possible effects of short-duration daily administration of these spices on selected haematological and biochemical parameters instead of relying on the long-term studies.

The results obtained from the short-term garlic and ginger extract administration on haematological and biochemical profiles of wistar rats were compared with similar studies that focused on long-term effects.

MATERIALS AND METHODS

Procurement of Samples and Preparation of Sample Extracts

Already pulverized garlic and ginger samples were purchased from three different sellers at Lokoja International Market, Lokoja, Kogi State, Nigeria, and transported to the lab in sterilized containers. Each sample was verified by certified taxonomists in the Science Laboratory Department of Kogi State Polytechnic, Lokoja, Kogi State, Nigeria.

The sample extracts were obtained following the method adopted by Abdullahi et al. (2024) and Dauda et al. (2025). Each sample (about 200 g) was soaked in 500 ml of ethanol. The combined extract was filtered with Whatman No. 1 filter

paper and the resulting solution was evaporated by subjecting to heat using water bath heater at 55 ^{o}C to obtain the extract.

Experimental Animals and Research Design

Nine female Wistar rats with average weight of 150 g were used in the experiment for each of the sample. (A total of eighteen female Wistar rats were used in this study). The rats were fed commercial rat feed pellets and water ad libitum under a natural light/dark cycle. The animals were kept in standard wooden cage at the animal house under a strict compliance with the guide for animal research, as detailed in (NIH, 1985) Guidelines for the Care and Use of Laboratory Animals. The animals were allowed to acclimatize in the standard wooden cage for 2 weeks before the commencement of the study as to allow for adaptation of life in the cage.

The nine rats for garlic sample were divided into three groups (A, B, and C) of three animals each; while Group A was the control group, Groups B and C were the experimental groups. Each Wistar rat in Group B and Group C was administered orally 100 mg/kg bodyweight and 200 mg/kg bodyweight garlic extracts, respectively for ten days. However, Wistar rats in Group A were only administered orally with normal saline (0.9 w/v) for the duration of the experiment.

The nine rats for ginger sample were treated in same manner as those for garlic sample as explained above.

Sample Collection and Analysis

Blood samples were collected from the orbital sinus of the rats into EDTA anti-coagulant test tubes 24 hours after the last extract administration. Haematological parameters were determined as described by Guyton and Hall (2006).

Drops of whole blood samples were used to fill heparinized microhematocrit capillary tubes to determine packed cell volume (PCV), and hemoglobin (Hb). Each whole blood sample was also used to make three air dried blood smears. The smears were stained with Wright's stain and examined for red blood cell (RBC), white blood cell (WBC), differential WBCs (lymphocytes, neutrophil, monocytes) and platelet estimate, while Mean corpuscular haemoglobin (MCH), Mean corpuscular haemoglobin concentration (MCHC) and Mean corpuscular volume (MCV) were calculated.

Total protein, albumin, serum alanine aminotransferase (ALT), total bilirubin, and conjugated bilirubin were determined by use of automated analysers as described by Meyer and Harvey (1998).

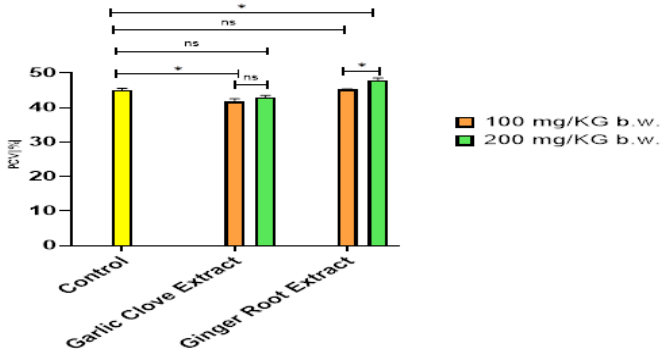
Statistical Analysis

Results were presented as mean and SEM for 3 animals per group. Significant difference was established at 5% level by one- way ANOVA followed by Duncan post – hoc test for multiple comparisons using GraphPad Prism Version 10.

RESULTS AND DISCUSSION

The present study demonstrates that short-term administration of garlic and ginger extracts produced variable effects on the haematological and biochemical profiles of Wistar rats. The responses differed according to the type of extract and dose administered, suggesting that the biological effects of these spices are influenced by both dose and duration of exposure.

Effect of Garlic and Ginger Extracts on Haematological Parameters

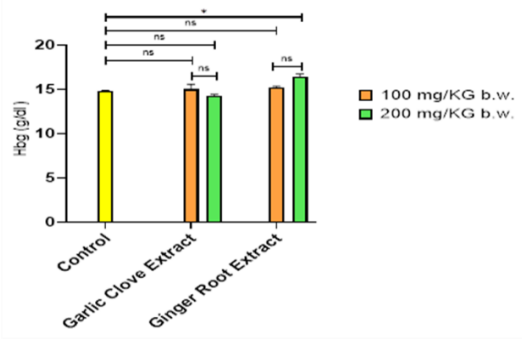


*P = 0.0336, ns (P > 0.05), (n = 3 per group)

Figure 1: Effect of Garlic and Ginger Extracts on PCV

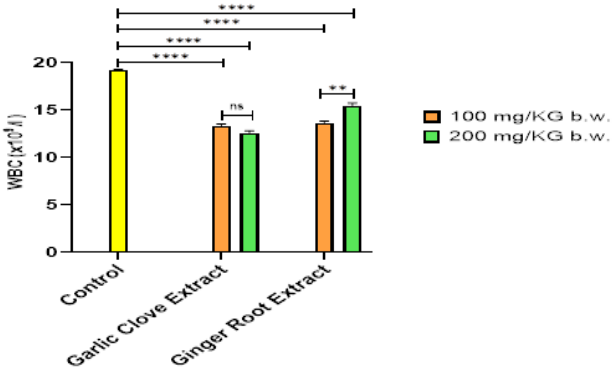
Garlic extract at 100 mg/kg significantly reduced PCV, while the reduction at 200 mg/kg was not significant. The reduction may indicate a short-term effect of garlic on erythrocyte production or survival. This finding contrasts with Ahmad et al. (2024), who reported a significant increase in PCV following 21 days of garlic administration. The difference may be related to the longer exposure period in their study, suggesting that the beneficial haematological effects of garlic may become more evident with prolonged administration.

In contrast, ginger produced an increase in PCV, with the 200 mg/kg dose producing a significant increase. This may be associated with the antioxidant and haematopoietic properties of ginger, which can help protect erythrocytes from oxidative damage. The finding agrees with Ahmad et al. (2024) and Ukoha et al. (2024), who reported improvements in haematological parameters following administration of plant extracts and spices.



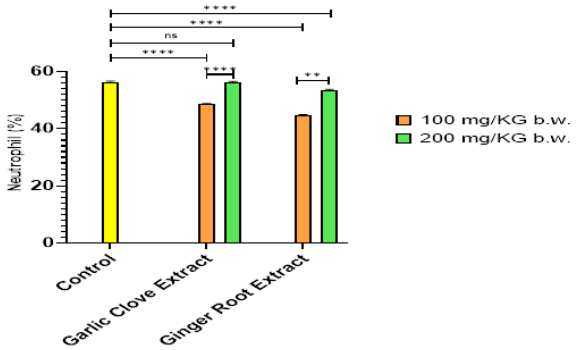
*P = 0.0277, ns (P > 0.05) ,(n = 3 per Group)
Figure 2: Effect of Garlic and Ginger Extracts on Hb

Similarly to PCV, haemoglobin was significantly increased (P = 0.0277) only by 200 mg/kg ginger extract. This may reflect improved erythrocyte synthesis or protection of erythrocytes through the antioxidant activity of ginger phytochemicals. The finding is consistent with Ahmad et al. (2024), who reported increased haemoglobin following longer-term administration of garlic and ginger. The absence of significant changes in the other groups may be due to the shorter exposure period, which may have been insufficient to produce substantial changes in haemoglobin concentration.



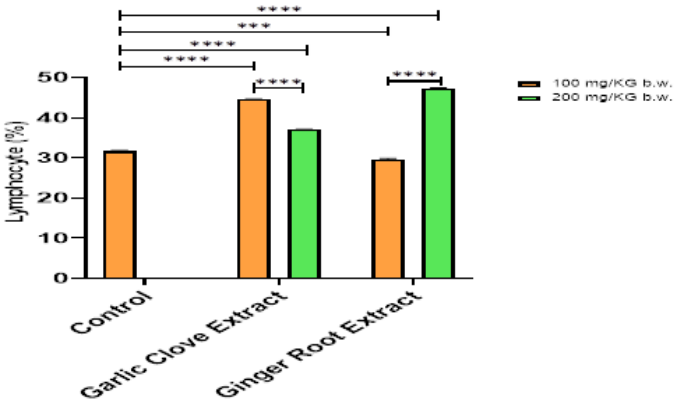
****P < 0.0001, **P = 0.0010, ns (P > 0.05), (n = 3 per Group)
Figure 3: Effect of Garlic and Ginger Extracts on WBC

WBC count significantly decreased in all garlic and ginger-treated groups compared with the control (P < 0.0001). This may indicate short-term modulation of leukocyte production or distribution.
The finding contrasts with Ahmad et al. (2024), who reported increased WBC counts after 21 days of garlic and ginger administration. The difference may be due to the shorter exposure period in the present study. The lack of significant difference between garlic doses suggests no clear dose effect, whereas ginger showed a significant dose-related response (P = 0.0010).



**** P < 0.0001, ns (P > 0.05), (n = 3 per Group)
Figure 4: Effect of Garlic and Ginger Extracts on Neutrophils

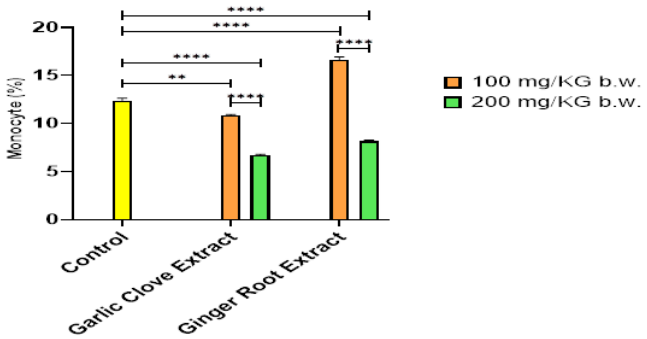
Neutrophil counts significantly decreased in the garlic- and ginger-treated groups compared with the control (P < 0.0001), except the 200 mg/kg bodyweight ginger extract which exerted no significant influence on neutrophil levels (P > 0.05). This may indicate short-term modulation of innate immune responses by the extracts.
The finding is consistent with the observed reduction in total WBC and may reflect altered leukocyte distribution following treatment. The response differed between doses, particularly with ginger, suggesting a possible dose-dependent effect.



****P < 0.0001; ***P = 0.0001 (n = 3 per Group)
Figure 5: Effect of Garlic and Ginger Extracts on Lymphocytes

Garlic and ginger extracts significantly ($p < 0.05$) influenced lymphocyte counts; 100 mg/kg and 200 mg/kg body weight of garlic extracts significantly ($P < 0.0001$) increased lymphocyte levels in the experimental animals when compared to the control group. However, while 100 mg/kg bodyweight ginger extract significantly ($P = 0.0001$) reduced lymphocyte levels, the higher dose extract significantly ($P < 0.0001$) increase the amounts in the experimental animals compared to the control.

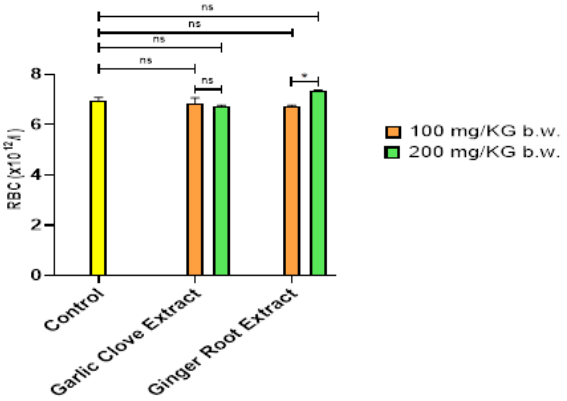
These changes suggest that the extracts may modulate immune responses. The increase in lymphocytes following garlic treatment may be related to organosulfur compounds that influence immune-cell activity. The different responses to ginger may reflect differences in dose and the concentration of its bioactive constituents.



****P < 0.0001, **P = 0.0017, (n = 3 per group)
Figure 6: Effect of Garlic and Ginger Extracts on Monocytes

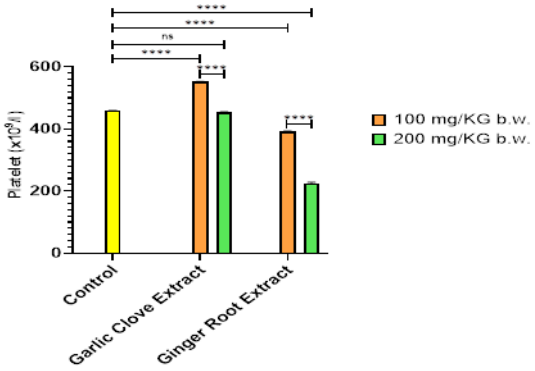
Figure 6 shows that the garlic extracts (100 and 200 mg/kg bodyweight) significantly reduced monocytes in the experimental animals compared to the control. However, while 100 mg/kg bodyweight of ginger extract significantly reduced monocytes, the 200 mg/kg bodyweight significantly increased monocytes compared to the control group.

Since monocytes are important components of innate immunity, these changes may indicate modulation of inflammatory and immune processes rather than a simple stimulation or suppression of immunity.



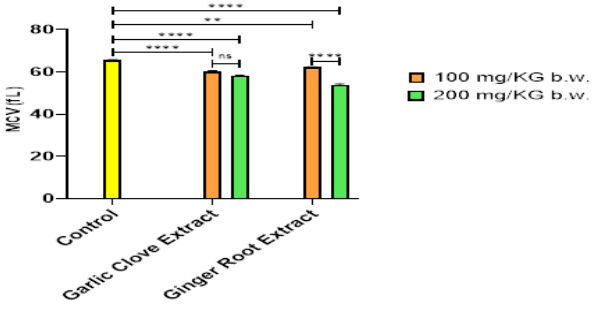
*P = 0.0323, nsP > 0.05 (n = 3 per Group)
Figure 7: Effect of Garlic and Ginger Extracts on RBC

The administration of 100 and 200 mg/kg bodyweight extracts of the two spices for 10 days offered no significant changes in the RBC levels. However, Ahmad et al. (2024) reported improved RBC counts following administration of garlic and ginger in rats. This shows that for daily administration of garlic or ginger extracts to exert significant changes on RBC counts, administration must be done for more than 10 days as showed by Ahmad et al. (2024).



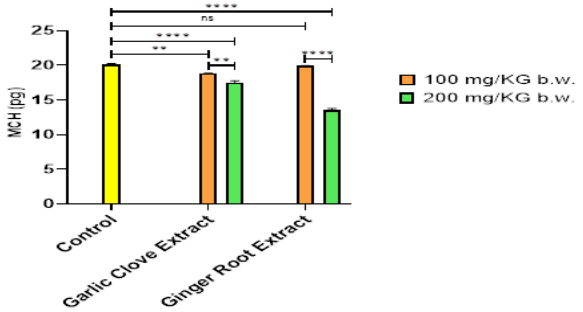
****P < 0.0001; nsP > 0.05 (n = 3 per Group)
Figure 8: Effect of Garlic and Ginger Extracts on Platelets

The significant effect on platelet count (figure 8) demonstrates that garlic and ginger may influence thrombopoiesis and hemostatic regulation. Platelets are essential for blood clotting and vascular integrity.
The 200 mg/kg bodyweight exerted no significant effect (P > 0.05) on platelet levels whereas the 100 mg/kg bodyweight significantly increased the haematological parameter compared to the control group. The ginger extracts (100 and 200 mg/kg bodyweight) both significantly (P < 0.0001) reduced the platelet levels compared to the control, clearly exhibiting anti-clotting potential.



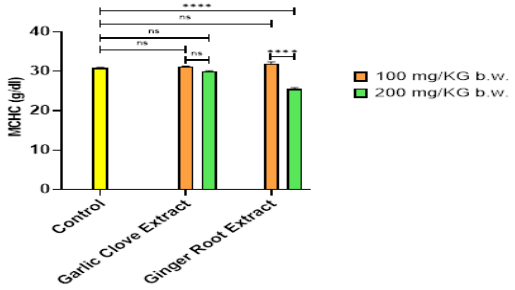
****P < 0.0001, **P = 0.0022, nsP > 0.05 (n = 3 per Group)
Figure 9: Effect of Garlic and Ginger Extracts on MCV

Mean corpuscular volume (MCV) (figure 9) was significantly altered following a ten-day administration, suggesting that garlic and ginger may influence erythrocyte morphology and maturation. MCV reflects the average size of red blood cells and is useful in evaluating erythropoietic activity and anaemia classification.
Both the garlic and ginger extracts (100 and 200 mg/kg bodyweight) significantly reduced the MCV levels in the experimental groups compared to the control group. While there's no observable significant difference (P > 0.05) between the two garlic extracts in the influence on MCV, the 100 mg/kg bodyweight of ginger extract was significantly different (P < 0.0001) from the 200 mg/kg bodyweight ginger extract, with the latter exhibiting more reduction in MCV levels.



****P < 0.0001, **P = 0.0022, nsP > 0.05 (n = 3 per group)
Figure 10: Effect of Garlic and Ginger Extracts on MCH

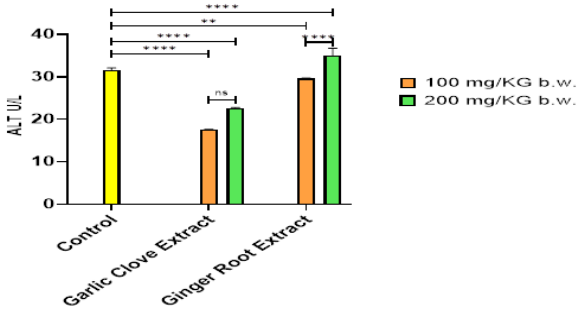
The significant effect on mean corpuscular hemoglobin (MCH) (figure 10) indicates possible enhancement of hemoglobin incorporation into erythrocytes. MCH measures the average quantity of hemoglobin per red blood cell and is influenced by erythrocyte maturation and iron metabolism.
The current study shows a significant reduction in MCH in all the experimental groups except the group for 200 mg/kg body weight of ginger extract which exhibited no significant influence on the MCH levels. The significant reduction in MCH in this study has demonstrated that hemoglobin incorporation into erythrocytes is affected following a ten-day administration of the extracts in the experimental animals.



****P < 0.0001, nsP > 0.05 (n = 3 per Group)
Figure 11: Effect of Garlic and Ginger Extracts on MCHC

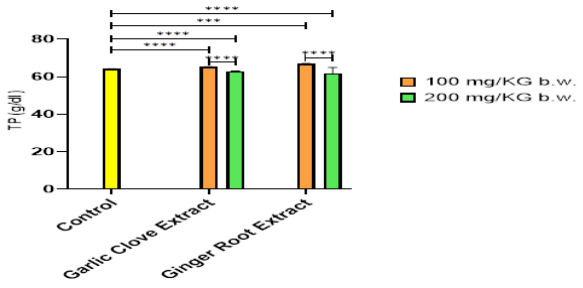
Mean corpuscular hemoglobin concentration MCHC reflects the average concentration of hemoglobin in packed red blood cells and serves as an indicator of erythrocyte quality and oxygen-carrying efficiency. Only the 200 mg/KG bodyweight of ginger extract exerted significant (P < 0.0001) reduction in MCHC levels compared to the control group. The remaining three extracts (100 and 200 mg/kg bodyweight of garlic extract and 100 mg/kg bodyweight of ginger extract) exerted no significant influence on the MCHC levels.

Effect of Garlic and Ginger Extracts on Biochemical Parameters



****P < 0.0001, **P = 0.0064, nsP > 0.05 (n = 3 per Group)
Figure 12: Effect of Garlic and Ginger Extracts on ALT

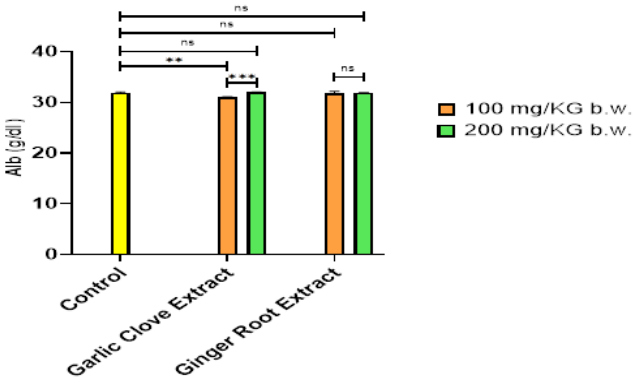
Alanine aminotransferase (ALT) is a sensitive biomarker of hepatocellular integrity. The significant changes observed following administration of garlic and ginger extracts suggest that these spices influenced hepatic metabolism and liver function. Garlic and ginger possess potent antioxidant compounds capable of reducing hepatic oxidative damage and improving detoxification processes.
The current study shows that 100 and 200 mg/kg bodyweight extracts of garlic and 100 mg/kg bodyweight of ginger extract significantly (P < 0.05) reduce the ALT levels in the experimental animals compared to the control. However, the 200 mg/kg bodyweight of ginger showed a significant increase in ALT levels, exhibiting hepatotoxic potential.
Ahmad A. I. et al. (2023a) reported alterations in serum biochemical parameters following administration of food spices in Wistar rats, supporting the present findings. Same results were obtained by daily administration of palm kernel oil (Ahmad et al., 2023b). The results imply that short-term administration is sufficient to modify hepatic enzyme activity.



****P < 0.0001, ***P = 0.0005 (n = 3 per Group)
Figure 13: Effect of Garlic and Ginger Extracts on Total Protein

Total protein reflects the combined concentration of albumin and globulins, which are important for osmotic balance, immunity, and nutrient transport.

In the current study, 100 mg/kg bodyweight of both spices significantly ($P < 0.05$) increased the total protein levels in the experimental animals compared to the control group. However, the 200 mg/kg bodyweight of both spices showed a significant ($P < 0.05$) decrease, implying the possible effects of increasing amounts of the spices consumed.

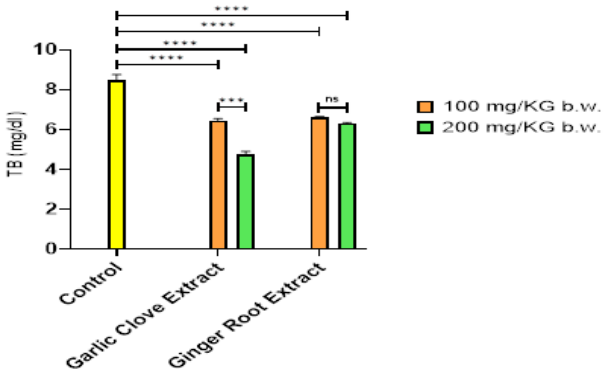


*** P = 0.0002, **P = 0.0012, ns (P > 0.05) (n = 3 per Group)

Figure 14: Effect of Garlic and Ginger Extracts on Albumin

Albumin is synthesized in the liver and serves as a major transport and osmotic protein. Increased albumin levels may indicate enhanced hepatic synthetic activity and improved nutritional metabolism.

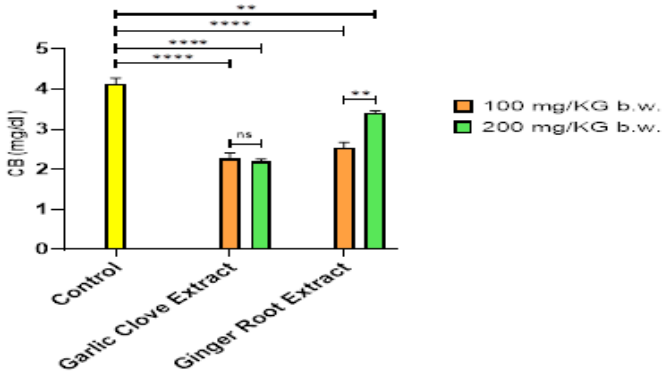
All the garlic and ginger extracts, except the 100 mg/kg bodyweight extract of garlic clove, exerted no significant influence on albumin levels. For a significant influence to be observed, administration will have to take place for more than 10 days.



****P < 0.0001, ***P = 0.0001, ns (P > 0.05) (n = 3 per Group)

Figure 15: Effect of Garlic and Ginger Extracts on Total Bilirubin

The garlic and ginger extracts studied significantly ($P < 0.0001$) reduce the total bilirubin levels in the experimental animals when compared to the control group. The reduction in bilirubin levels may indicate improved hepatic clearance and reduced hemolysis due to antioxidant protection of erythrocytes.



****P < 0.0001, **P = 0.0029, ns (P > 0.05); (n = 3 per group)

Figure 16: Effect of Garlic and Ginger Extracts on Conjugated Bilirubin

The significant effect on conjugated bilirubin suggests modulation of hepatic conjugation and biliary excretion processes by garlic and ginger extracts. Conjugated bilirubin reflects bilirubin processed by the liver for excretion. Alterations in its concentration may therefore indicate changes in hepatic metabolic efficiency.
The current study showed that all the extracts significantly ($P < 0.05$) reduced conjugated bilirubin levels in the experimental animals compared to the control group.

CONCLUSION

The present study demonstrates that short-term administration of garlic and ginger extracts can significantly alter selected haematological and biochemical parameters in Wistar rats. The effects varied according to the type of extract and dose administered. Garlic produced a significant reduction in PCV at 100 mg/kg, while ginger, particularly at 200 mg/kg, improved PCV and haemoglobin levels. Both extracts produced significant changes in white blood cells, neutrophils, lymphocytes, monocytes, platelets, MCV and MCH, indicating that short-term exposure can influence haematological and immune-related parameters.
The biochemical findings further demonstrated that garlic and ginger affected hepatic and metabolic parameters. Lower doses generally reduced ALT, whereas 200 mg/kg ginger increased ALT, suggesting that the response to ginger may be dose-dependent. Both extracts significantly reduced total and conjugated bilirubin, while total protein showed an increase at 100 mg/kg and a decrease at 200 mg/kg. Overall, the findings indicate that the physiological effects of garlic and ginger are not uniform and may depend on both dose and duration of exposure.

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