Food Science & Applied Microbiology Reports
Vol. 4(1), 2025, 1-10
ISSN (Online) 2958-0684
https://finessepublishing.com/fsamr

Nutritional properties of *Ugu* leaves extract and its effects on the haematological profile of anaemia-induced adult Wistar rats

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Abstract: Anaemia is a global health concern, particularly in developing countries, where nutritional interventions are explored for management. *Telfairia occidentalis (Ugu)* is traditionally used for its nutritional and medicinal benefits, but its anti-anaemic potential requires scientific validation. This study investigated the nutrient composition of *Telfairia occidentalis* leaf extract and its effects on the haematological profile of anemia-induced adult Wistar rats. Nutrient analysis was conducted using standard analytical methods. Thirty adult male Wistar rats (170g–185g) were divided into six groups: A (standard drug—Cameron), B (untreated), and C–F (250mg, 500mg, 750mg, and 1000mg/kg body weight of *Telfairia occidentalis* extract, respectively). Anemia was induced using phenylhydrazine (40mg/kg). Treatment lasted 14 days. Haematological parameters were analyzed using standard methods, and data were subjected to ANOVA ($p<0.05$). Nutrient analysis revealed *Telfairia occidentalis* contained 14.36% moisture, 7.96% ash, 1.00% fat, 24.34% protein, 38.59% fibre, 13.75% carbohydrate, 1356.65µg beta-carotene, 24.76mg vitamin B9, 29.09mg vitamin C, 4.10mg iron, 1442.50mg calcium, and 864.50mg magnesium. Rats treated with the extract showed dose-dependent weight gain, with the highest increase (86.92%) in Group F (1000mg/kg). Haematological parameters, including red and white blood cell counts, significantly improved after treatment ($p<0.05$). *Telfairia occidentalis* extracts exhibit anti-anaemic properties and improve haematological parameters. Further research is needed to validate its therapeutic potential in clinical trials.

Keywords: *Telfairia occidentalis*, anaemia, haematology, nutrient composition, Wistar rat.

1. Introduction

Anaemia is a major global health concern, particularly in developing countries where nutritional deficiencies play a significant role in its prevalence. Iron deficiency anemia, the most common form, affects millions of individuals, leading to fatigue, impaired cognitive function, and decreased productivity. While conventional treatments such as iron supplements and pharmaceutical interventions exist, they often come with side effects, prompting the exploration of natural alternatives. *Telfairia occidentalis (fluted pumpkin)*, commonly known as "*ugu,*" is widely consumed in West Africa and is traditionally used for its purported hematopoietic and medicinal properties. However, limited scientific research has focused specifically on the nutritional composition of its extracts and their potential anti-anaemic effects. The nutritional composition of *Telfairia occidentalis* leaves plays critical roles in red blood cell production and function, suggesting that their presence in the extract could contribute to haematological improvements in anemia-induced subjects. In been extensively studied, but there is limited research on the specific composition of its extracts. Understanding the nutrient profile of the extract is essential in evaluating its potential role in anemia management. Studies by Esonu et al. (2006) and Ochokwu et al. (2021) have shown that *Telfairia occidentalis* leaves contain significant amounts of protein, fiber, and minerals such as iron, calcium, and magnesium, which are essential for blood formation and overall health. The presence of these nutrients in the extract would suggest its potential therapeutic application in improving haematological parameters. The vitamin content of *Telfairia occidentalis* has also been explored in various studies. Olorunfemi et al. (2018) reported that dried ugu leaves contain high levels of ascorbic acid, while Agogbua et al. (2022) found substantial amounts of β-carotene and vitamin B9.

[Received] 14 Mar 2025; Accepted 15 May 2025; Published (online) 18 May 2025]
Finesse Publishing stays neutral concerning jurisdictional claims published maps

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DOI: 10.61363/7zvbsb26

These vitamins addition to its macronutrient and micronutrient content, *Telfairia occidentalis* has been recognized for its antioxidant properties. The study by Usonobun and Egharebva (2014) highlighted the phytochemical components and mineral composition of the aqueous extract, reinforcing its potential medicinal benefits. The antioxidant activity of the extract could further support red blood cell health by reducing oxidative stress, which is often elevated in anaemic conditions. Despite these findings, there remains a gap in research regarding the direct effects of *Telfairia occidentalis* extract on haematological parameters in anaemic conditions. By analysing the proximate, mineral, and vitamin composition of the extract and assessing its impact on anemia induced Wistar rats, this study aims to provide empirical evidence on its potential anti-anaemic effects. The outcomes of this research will contribute to a better understanding of the nutritional and therapeutic benefits of *Telfairia occidentalis* extract, supporting its possible use in managing anemia through dietary interventions.

2. Materials and Methods

This study adopted an experimental design to evaluate the nutrient composition of *Telfairia occidentalis (ugu)* leaves extract and its effect on haematological parameters in anemia-induced adult Wistar rats.

2.1. Purchasing

Ugu leaves were purchased from Ogige Market, Nsukka, and identified at the Department of Botany, University of Nigeria, Nsukka. Rat chow was procured from the Department of Veterinary Medicine, University of Nigeria, Nsukka.

2.2. Sample preparation

Sample Preparation was done following the method of Danborno et al. (2019), *ugu* leaves were washed, air-dried for two days, oven-dried at 40°C for 24 hours, ground into powder, and analyzed, including RBC, PCV, Hb, WBC, differential counts, platelet counts, MCV, and MCH (Danborno et al., 2019). And stored in an airtight container for further use.

2.3. Extraction

Ugu Leaves Extract was prepared using the method by Ebenyi et al. (2021). Two hundred grams of powdered ugu leaves were steeped in 2000 mL of boiled distilled water (100°C) for 48 hours, intermittently shaken, sieved, and the extract was used for treatment.

2.4. Physicochemical analysis

Determination Moisture, protein, fat, ash, and crude fiber contents were analysed using AOAC (2010) methods. Carbohydrate content was determined by difference. Iron, calcium, and magnesium were analysed using AOAC (2010) methods. Iron was determined by spectrophotometry at 510 nm, calcium by titration with KMnO4, and magnesium by EDTA titration. Vitamin C was analysed by redox titration, folate by HPLC, and vitamin A by spectrophotometry at 446 nm (AOAC, 2010).

2.5. Animal study

Thirty adult Wistar rats (170–185 g) were obtained from the Faculty of Veterinary Medicine, University of Nigeria, Nsukka. They were housed in metabolic cages under standard conditions and acclimatized for four days. Anemia was induced by intraperitoneal injections of phenylhydrazine (40 mg/kg) for two consecutive days. Rats were considered anaemic when RBC and haemoglobin levels reduced by 30% (Sheth et al., 2021). The rats were divided into six groups (n=5). Group 1 (positive control) received cemeron, Group 2 (negative control) received no treatment, and Groups 3–6 received 250 mg, 500 mg, 750 mg, and 1000 mg/kg body weight of *ugu* extract, respectively, for 14 days. After 18 days, rats were sacrificed, and blood was collected via cardiac puncture for haematological analysis using an Auto Haematology Analyzer.

2.6. Study design

We adopted the following study design in our investigation.
Group A: Anaemic rats treated with 250 mg/kg body weight of the standard drug (control)
Group B: Anaemic rats fed 0mg/kg body weight of *Telfairia occidentalis* extract daily (anaemic untreated)
Group C: Anaemic rats fed 250 mg/kg body weight of *Telfairia occidentalis* extract daily
Group D: Anaemic rats fed 500 mg/kg body weight of *Telfairia occidentalis* extract daily
Group E: Anaemic rats fed 750 mg/kg body weight of *Telfairia occidentalis* daily
Group E: Anaemic rats fed 1000 mg/kg body weight of *Telfairia occidentalis* extract daily

Food Science & Applied Microbiology Reports
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https://finessepublishing.com/fsamr

2.7. Statistical Analysis

Statistical Analysis Data were analysed using SPSS (Version 20). Means and standard deviations were determined, and ANOVA was used for mean separation. Significance was accepted at $p \leq 0.05$ using Duncan's multiple range test.

3. Results and discussion

3.1. Proximate composition of *Telfairia occidentalis* leaf extract

Table 1 shows the proximate composition of *Telfairia occidentalis* leaf extract. The moisture, ash, crude fat, crude fiber, crude protein, and carbohydrate contents of the sample were 14.36%, 7.96%, 1.00%, 38.59%, 24.34% and 13.75%, respectively. The proximate analysis revealed that *Telfairia occidentalis* leaf extract is a rich source of fiber (38.59%), contrasting with Ochokwu et al. (2021), who reported 14.33% in leaf meal. Fiber benefits digestive health and has anti-anaemic properties. The moisture content (14.36%) differed from Abdussamad et al. (2016), who found 7.45% in fresh leaves, possibly due to differences between leaves and extract. The ash content (7.96%) aligned closely with Abdussamad et al. (2016), indicating mineral presence.

Table 1. Mean proximate composition of *Telfairia occidentalis* leaf extract.

Nutrient	Value (%)
Moisture	14.36 ± 0.70
Ash	7.96 ± 1.35
Crude fat	1.0 ± 0.01
Crude fiber	38.59 ± 1.05
Crude protein	24.34 ± 0.50
Total carbohydrate	13.75 ± 2.20

Values are means ± standard deviation of duplicate determination.

3.2. Vitamin contents of *Telfairia occidentalis* leaf extract

Table 2 shows the vitamin contents of *Telfairia occidentalis* leaf extract per 100g. The beta-carotene, vitamin B9, and vitamin C contents of the sample were 1356.65 µg, 24.76 mg, and 29.09 mg, respectively. The beta-carotene content (1356.65 µg) was significantly higher than Agbua et al. (2022), who found 200 µg in water-grown leaves. Vitamin B9 (24.76 mg) was lower than Agbua et al. (2022) at 78.2 mg, while vitamin C (29.09 mg) was comparable to Olorunfemi et al. (2018), who reported 36.00 mg. These vitamins play crucial roles in immune function and anemia management.

Table 2. Vitamin contents of *Telfairia occidentalis* leaf extract per 100g.

Vitamins	Value
Beta-carotene (µg)	1356.65 ± 13.90
Vitamin B_9 (mg)	24.76 ± 1.96
Vitamin C (mg)	29.09 ± 2.21

Values are means ± standard deviation of duplicate determination.

3.3. Mineral contents of *Telfairia occidentalis* leaf extract

Table 3 shows the mineral contents of *Telfairia occidentalis* leaf extract per 100g. The iron content of the sample was 4.10 mg, while the calcium and magnesium contents were 1442.50 mg and 864.48 mg, respectively.
Carbohydrate content (14.75%) was lower than Adeyeye et al. (2011), who reported 33.4%, suggesting variability between leaves and extract. The crude protein value (24.34%) was consistent with Esonu et al. (2006), highlighting its potential as a plant-based protein source. Mineral analysis showed high iron (4.10 mg), calcium (1442.50 mg), and magnesium (864.48 mg). The iron level was like Abdussamad et al. (2016) (3.7 mg), supporting its role in haemoglobin formation. However, calcium content greatly exceeded Adeyeye et al. (2011) (14.3 mg), while magnesium was higher than Usonobun & Egharebva (2014) (61.03 mg), indicating potential variations due to soil and processing methods.

Table 3. Mineral contents of *Telfairia occidentalis* leaf extract per 100g.

Mineral	Value
Iron (mg)	4.10 ± 0.14
Calcium (mg)	1442.50 ± 3.54
Magnesium (mg)	864.48 ± 0.67

Values are means ± standard deviation of duplicate determination.

3.4. Mean body weight (g) of the rats

Table 4 shows the mean body weights of the rats before and after the experiment. The mean weights of groups A, C, D, E, and F increased by 6.22%, 2.47%. 5.55%. 8.24% and 6.92%, respectively, while that of group B (induced, untreated) decreased by 5.60%. Group E had the highest percentage increase in body weight, while group D had the least percentage increase in body weight. There were significant ($p<0.05$) changes in the mean body weights of groups A, C, D, E, and F after the experiment.

Table 4. Mean body weights of the rats (g) before and after the experiment.

Group	Before anaemia induction	After anaemia induction (Baseline)	After experiment (End value)	Diff (end value-baseline)	Percentage diff (%)
A	$181.60^{b} \pm 5.18$	$173.60^{bc} \pm 3.21$	$184.40^{c} \pm 4.98$	10.80	6.22 ↑
B	$173.20^{a} \pm 4.32$	$164.40^{a} \pm 3.36$	$155.20^{a} \pm 1.92$	-9.2	5.60 ↓
C	$185.80^{b} \pm 2.58$	$178.00^{d} \pm 2.92$	$182.40^{bc} \pm 4.98$	4.4	2.47 ↑
D	$182.60^{b} \pm 3.05$	$176.60^{cd} \pm 2.79$	$186.40^{c} \pm 2.70$	9.8	5.55 ↑
E	$170.60^{a} \pm 3.05$	$165.00^{a} \pm 3.67$	$178.60^{b} \pm 2.70$	13.6	8.24 ↑
F	$175.20^{a} \pm 4.21$	$170.40^{b} \pm 2.61$	$182.20^{bc} \pm 3.49$	11.8	6.92 ↑

Values are expressed as MeanSD of each rat group (n=5). Mean values on the same column/row with different superscripts are significant at P<0.05.

3.5. Haematological indices of rats

Table 5 shows the mean serum packed cell volume (PCV) of the rats before and after the experiment. The PCV level of the rats decreased in group B (anaemic untreated) by 23.68% but increased in the treated groups A, C, D, E, and F by 97.20%, 20.16%, 49.59%, 64.52% and 58.21%, respectively, after the experiment. Group A had the highest percentage increase in PCV, while group C had the least percentage decrease. Statistically significant ($P < 0.05$) differences were observed in the PCV levels of groups A, B, C, D, E, and F after the experiment. Haematological analysis revealed that *ugu* extract improved RBC, HB, and PCV levels in anaemic rats, aligning with the positive control. Extract-treated groups (C–F) gained weight (2.47%–8.24%), whereas the untreated anaemic group (B) lost 5.60%. This suggests that the extract enhances nutrient absorption and recovery from anemia. A dose-dependent response indicated that higher doses (750 mg and 1000 mg) were most effective.

Table 5. Mean serum packed cell volume (PCV) of the rats (%) before and after the experiment.

Group	Before anaemia induction	After anaemia induction (Baseline)	After experiment (End value)	Diff (end value-baseline)	Percentage diff (%)
A	$42.20^{a} \pm 2.28$	$21.40^{a} \pm 2.97$	$42.20^{d} \pm 1.79$	20.8	97.20 ↑
B	$41.60^{a} \pm 2.07$	$22.80^{ab} \pm 1.64$	$17.40^{a} \pm 1.67$	-5.4	23.68 ↑
C	$42.20^{a} \pm 2.17$	$25.80^{bc} \pm 1.64$	$31.00^{b} \pm 2.00$	5.2	20.16 ↓
D	$41.80^{a} \pm 1.30$	$24.60^{abc} \pm 2.97$	$36.80^{c} \pm 2.69$	12.2	49.59 ↑
E	$41.80^{a} \pm 1.48$	$24.80^{bc} \pm 2.39$	$40.80^{d} \pm 1.92$	16.0	64.52 ↑
F	$41.80^{a} \pm 1.79$	$26.80^{c} \pm 2.17$	$42.40^{d} \pm 1.67$	15.6	58.21 ↑

Values are expressed as MeanSD of each rat group (n=5). Mean values on the same column/row with different superscripts are significant at P<0.05.

Table 6 shows the serum total white blood cell (WBC) count of the rats before and after experiment. The total WBC of the rats increased in groups B (anaemic untreated) by 21.28% while that of treated groups A, C, D, E and F decreased by 26.22%, 10.53%, 24.76%, 28.21% and 28.06%, respectively after experiment with group E having the highest percentage decrease in WBC count and group C having the least percentage decrease.

Food Science & Applied Microbiology Reports
Vol. 4(1), 2025, 1-10
ISSN (Online) 2958-0684
https://finessepublishing.com/fsamr

Statistically, significant ($P < 0.05$) differences were observed in the WBC counts of groups A, B, C, D, E and F after experiment.

Table 6. Mean total white blood cell count of the rats (x 10mm3) before and after the experiment.

Group	Before anaemia induction	After anaemia induction (Baseline)	After experiment (End value)	Diff (end value-baseline)	Percentage diff (%)
A	$8300.00^{a} \pm 565.69$	$14340.00^{a} \pm 1295.37$	$10580.00^{ab} \pm 238.75$	-3760.0	26.22 ↓
B	$8480.00^{a} \pm 725.95$	$14100.00^{a} \pm 1034.41$	$17100.00^{d} \pm 1206.24$	3000.0	21.28 ↑
C	$8520.00^{a} \pm 311.45$	$13860.00^{a} \pm 1418.04$	$12400.00^{c} \pm 339.17$	-1460.0	10.53 ↓
D	$8560.00^{a} \pm 230.22$	$14700.00^{a} \pm 1104.54$	$11060.00^{b} \pm 702.14$	-3640.0	24.76 ↓
E	$8260.00^{a} \pm 207.36$	$14180.00^{a} \pm 228.04$	$10180.00^{ab} \pm 327.11$	-4000.0	28.21 ↓
F	$8260.00^{a} \pm 545.89$	$14040.00^{a} \pm 288.10$	$10100.00^{a} \pm 561.25$	-3940.0	28.06 ↓

Values are expressed as MeanSD of each rat group (n=5). Mean values on the same column/row with different superscripts are significant at $P<0.05$.

Table 7 presents the serum red blood cell (RBC) counts of the rats before and after the experiment. The RBC counts of group B (anaemic untreated) decreased by 11.73% after the experiment while that of the treated groups A, C, D, E and F increased by 68.77%, 42.07%, 57.70%, 69.72% and 49.84%, respectively after the experiment with group E having the highest percentage increase in RBC and group C having the least percentage increase. Statistically significant ($P <0.05$) changes were observed in the RBS counts of groups A, C, D, E, and F after the experiment. No significant ($p>0.05$) change was observed in the RBC counts of group B after the experiment.

Table 7. Mean red blood cell (RBC) counts of the rats (x106) before and after the experiment.

Group	Before anaemia induction	After anaemia induction (Baseline)	After experiment (End value)	Diff (end value-baseline)	Percentage diff (%)
A	$10.28^{a} \pm 0.20$	$6.18^{a} \pm 0.21$	$10.43^{d} \pm 0.19$	4.25	68.77 ↑
B	$9.91^{a} \pm 0.65$	$5.88^{a} \pm 0.21$	$5.19^{a} \pm 0.69$	-0.69	11.73 ↑
C	$10.40^{a} \pm 0.20$	$6.18^{a} \pm 0.33$	$8.78^{b} \pm 0.28$	2.60	42.07 ↓
D	$20.27^{a} \pm 0.20$	$6.17^{a} \pm 0.30$	$9.73^{c} \pm 0.36$	3.56	57.70 ↑
E	$10.17^{a} \pm 0.51$	$6.11^{a} \pm 0.23$	$10.37^{d} \pm 0.17$	4.26	69.72 ↑
F	$10.25^{a} \pm 0.28$	$6.18^{a} \pm 0.29$	$9.26^{bc} \pm 0.42$	3.08	49.84 ↑

Values are expressed as MeanSD of each rat group (n=5). Mean values on the same column/row with different superscripts are significant at $P<0.05$.

Table 8 shows the mean serum neutrophil level of the rats before and after the experiment. The neutrophil level of the rats in group B (anaemic untreated) increased by 7.20% while that of the treated groups A, C, D, E, and F decreased by 50.24%, 16.82%, and 33.85%. 49.30% and 50.93%, respectively, with group A having the highest percentage decrease in neutrophil and group C having the least percentage decrease after the experiment. Significant ($P<0.05$) changes in the neutrophil level were observed in groups A, B, C, D, E, and F after the experiment.

Table 8. Mean serum neutrophil levels of the rats (%) before and after the experiment.

Group	Before anaemia induction	After anaemia induction (Baseline)	After experiment (End value)	Diff (end value-baseline)	Percentage diff (%)
A	$21.40^{a} \pm 4.88$	$41.00^{ab} \pm 7.42$	$20.40^{a} \pm 2.70$	-20.6	50.24 ↓
B	$22.40^{a} \pm 5.13$	$47.20^{b} \pm 8.79$	$50.60^{c} \pm 7.33$	3.4	7.20 ↑
C	$20.40^{a} \pm 3.36$	$42.80^{ab} \pm 4.66$	$35.60^{b} \pm 4.62$	-7.2	16.82 ↓
D	$21.40^{a} \pm 3.36$	$39.00^{a} \pm 5.48$	$25.80^{a} \pm 3.96$	-13.20	33.85 ↓
E	$21.00^{a} \pm 3.94$	$43.00^{ab} \pm 5.70$	$21.80^{a} \pm 2.39$	-21.2	49.30 ↓

F	$19.20^{a} \pm 3.70$	$42.80^{ab} \pm 4.66$	$21.00^{a} \pm 3.39$	-21.8	50.93 ↓

Values are expressed as MeanSD of each rat group (n=5). Mean values on the same column/row with different superscripts are significant at P<0.05.

Table 9 shows the mean serum lymphocyte levels of the rats before and after treatment. The lymphocyte levels of the rats decreased in group B (anaemic untreated) by 10.38% but increased in the treated groups A, C, D, E, and F by 88.28%, 12.5%, 24.91%, 36.03% and 41.54%, respectively, with group A having the highest percentage increase in lymphocytes and group C having the least percentage increase. Significant ($p < 0.05$) increases in lymphocytes were observed in the treated groups A, C, D, E, and F after the experiment. No significant ($p>0.05$) difference was observed in the lymphocyte levels of group B after the experiment.

Table 9. Mean serum lymphocyte levels of the rats (%) before and after the experiment.

Group	Before anaemia induction	After anaemia induction (Baseline)	After experiment (End value)	Diff (end value-baseline)	Percentage diff (%)
A	$77.00^{a} \pm 4.47$	$47.80^{a} \pm 24.29$	$75.60^{c} \pm 3.78$	42.2	88.28 ↑
B	$75.20^{a} \pm 5.75$	$52.00^{a} \pm 8.37$	$46.60^{a} \pm 6.11$	-5.4	10.38 ↓
C	$78.00^{a} \pm 2.74$	$56.00^{a} \pm 4.69$	$63.00^{b} \pm 4.24$	7.0	12.5 ↑
D	$64.00^{a} \pm 31.93$	$58.60^{a} \pm 5.46$	$73.20^{c} \pm 4.60$	14.6	24.91 ↑
E	$77.00^{a} \pm 4.47$	$54.40^{a} \pm 7.13$	$74.00^{c} \pm 4.18$	19.6	36.03 ↑
F	$79.20^{a} \pm 2.39$	$54.40^{a} \pm 5.32$	$77.00^{c} \pm 4.80$	24.6	41.54 ↑

Values are expressed as MeanSD of each rat group (n=5). Mean values on the same column/row with different superscripts are significant at P<0.05.

Table 10 shows the mean monocyte levels of the rats before and after the experiment. The monocyte levels of the rats in the treated rat groups A, C, D, E, and F decreased by 350.0%, 50.0%, 50.0% and 46.15% respectively, after the experiment, with group B and E increased by 250.0% and 27.27%, respectively. Group A had the highest percentage decrease in monocyte level, while the treated groups F had the least percentage decrease in monocyte level after the experiment. Statistically significant ($p<0.05$) difference occurred in the monocyte levels of the rat groups A, B, C, D, E, and F after the experiment.

Table 10. Mean serum monocyte levels of the rats (%) before and after the experiment.

Group	Before anaemia induction	After anaemia induction (Baseline)	After experiment (End value)	Diff (end value-baseline)	Percentage diff (%)
A	$1.20^{a} \pm 1.30$	$0.40^{a} \pm 0.89$	$1.80^{ab} \pm 0.84$	1.40	350.0 ↓
B	$1.40^{a} \pm 1.52$	$0.80^{a} \pm 1.01$	$2.80^{b} \pm 1.48$	2.00	250.0 ↑
C	$1.20^{a} \pm 1.30$	$1.20^{ab} \pm 1.30$	$0.60^{a} \pm 0.55$	-0.6	50.0 ↓
D	$1.40^{a} \pm 1.14$	$2.00^{b} \pm 2.12$	$1.00^{a} \pm 0.71$	-1.00	50.0 ↓
E	$1.40^{a} \pm 1.52$	$2.20^{bc} \pm 1.92$	$2.80^{b} \pm 1.30$	0.6	27.27 ↑
F	$0.80^{a} \pm 1.10$	$2.60^{c} \pm 4.22$	$1.40^{ab} \pm 1.14$	-1.2	46.15 ↓

Values are expressed as MeanSD of each rat group (n=5). Mean values on the same column/row with different superscripts are significant at P<0.05.

Table 11 shows the serum basophil levels of the rats before and after the experiment. The basophil levels of the rats in control groups A and E increased significantly ($p<0.05$) after the experiment, while those of groups B, C, D, and F remained the same after the experiment.

Table 11. Mean serum basophil levels of the rats (%) before and after the experiment

Group	Before anaemia induction	After anaemia induction (Baseline)	After experiment (End value)	Diff (end value-baseline)	Percentage diff (%)
A	$0.00^{a} \pm 0.00$	$0.00^{a} \pm 0.00$	$1.00^{c} \pm 0.71$	1.00	-
B	$0.40^{a} \pm 0.55$	$0.00^{a} \pm 0.00$	$0.00^{a} \pm 0.00$	-	-

Food Science & Applied Microbiology Reports
Vol. 4(1), 2025, 1-10
ISSN (Online) 2958-0684
https://finessepublishing.com/fsamr

C	$0.20^{a} \pm 0.45$	$0.00^{a} \pm 0.00$	$0.00^{a} \pm 0.00$	-	-
D	$0.20^{a} \pm 0.45$	$0.00^{a} \pm 0.00$	$0.00^{a} \pm 0.00$	-	-
E	$0.20^{a} \pm 0.45$	$0.00^{a} \pm 0.00$	$0.60^{ab} \pm 0.55$	0.6	-
F	$0.40^{a} \pm 0.55$	$0.20^{a} \pm 0.45$	$0.20^{a} \pm 0.45$	0.00	-

Values are expressed as MeanSD of each rat group (n=5). Mean values on the same column/row with different superscripts are significant at P<0.05.

Table 12 shows the mean serum eosinophil levels of the rats before and after the experiment. The eosinophil levels of the rats in the treated group D decreased by 100% while that of group E increased by 250.0%. A percentage increase in eosinophil level was also observed in group A, while that of groups B, C, and F remained unchanged after the experiment.

Table 12. Mean serum eosinophil levels of the rats (%) before and after the experiment

Group	Before anaemia induction	After anaemia induction (Baseline)	After experiment (End value)	Diff (end value-baseline)	Percentage diff (%)
A	$0.40^{a} \pm 0.89$	$0.00^{a} \pm 0.00$	$1.20^{c} \pm 0.83$	1.20	-
B	$0.60^{a} \pm 0.45$	$0.00^{a} \pm 0.00$	$0.00^{a} \pm 0.00$	-	-
C	$0.20^{a} \pm 0.45$	$0.00^{a} \pm 0.00$	$0.00^{a} \pm 0.00$	-	-
D	$0.40^{a} \pm 0.55$	$0.40^{a} \pm 0.89$	$0.00^{a} \pm 0.00$	-4.0	100.0 ↓
E	$0.40^{a} \pm 0.55$	$0.40^{a} \pm 0.89$	$0.80^{bc} \pm 0.84$	0.40	250.0 ↑
F	$0.40^{a} \pm 0.55$	$0.20^{a} \pm 0.45$	$0.20^{ab} \pm 0.45$	0.00	-

Values are expressed as MeanSD of each rat group (n=5). Mean values on the same column/row with different superscripts are significant at P<0.05.

Table 13 shows the mean serum haemoglobin levels of the rats before and after the experiment. The haemoglobin levels of the rats in group D (anaemic untreated) decreased by 14.09% after experiment while that of the treated rat groups A, C, D, E and F increased by 50.0%, 26.05%, 43.20%, 49.84% and 48.87%, respectively with group A having the highest percentage increase in haemoglobin and group C having the least percentage increase in Hb after experiment. Statistically significant ($p<0.05$) increases in Hb were observed in the treated rat groups A, C, D, E, and F after the experiment. However, no significant ($p <0.05$) difference occurred between the Hb levels of group B (anaemic untreated) after the experiment.

Table 13. Mean serum haemoglobin (Hb) levels of the rats (g/dl) before and after the experiment

Group	Before anaemia induction	After anaemia induction (Baseline)	After experiment (End value)	Diff (end value-baseline)	Percentage diff (%)
A	$8.36^{a} \pm 0.15$	$6.04^{a} \pm 0.55$	$9.06^{c} \pm 0.34$	3.02	50.0 ↑
B	$8.40^{a} \pm 0.35$	$5.96^{a} \pm 0.40$	$5.12^{a} \pm 0.80$	-0.84	14.09 ↓
C	$8.34^{a} \pm 0.69$	$6.22^{a} \pm 0.25$	$7.84^{b} \pm 0.39$	1.62	26.05 ↑
D	$8.48^{a} \pm 0.45$	$5.88^{a} \pm 0.13$	$8.42^{b} \pm 0.36$	2.54	43.20 ↑
E	$8.62^{a} \pm 0.73$	$6.22^{a} \pm 0.24$	$9.32^{c} \pm 0.40$	3.10	49.84 ↑
F	$8.46^{a} \pm 0.30$	$6.22^{a} \pm 0.24$	$9.26^{c} \pm 0.42$	3.04	48.87 ↑

Values are expressed as MeanSD of each rat group (n=5). Mean values on the same column/row with different superscripts are significant at P<0.05.

4. Conclusions

Future research should include a comprehensive haematological profile to assess the extract's impact on anemia. Human trials are necessary to evaluate efficacy and safety in treating iron deficiency anemia. Awareness should be raised on safe consumption levels of *ugu* leaf extracts.

Author's contribution

Ugwu Praise, Experiment and analyze data, Writing-original draft; Oluebube Chukwuka, Data analysis, Writing-original draft, editing, proofreading.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgments

This work was not financially supported by any funding agency.

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