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# Antioxidant, Hematological and Anti-obesity properties of *curcuma longa* and *mentha piperita* in Albino rats

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## Abstract

*Curcuma longa* (Tumeric) and *Mentha piperita* (Pepper mint) are spices commonly used for various curlinary, pharmacological and medicinal purposes. This study was done to determine the antioxidant, hematological and anti-obesity properties of both plants, when taken in single and combined forms. Forty- two (42) wistar rats of mixed gender, excluding pregnant animals were used for the experiment which lasted for six weeks. Animals were divided into seven groups. Group A (Normal Control group), were fed with commercial rat pellets. The experimental groups comprised of Group B, Group C, Group D, Group E, Group F and Group G which were fed with a combination of commercial rat pellets and plant samples in different percentages. The initial weight was taken, while subsequent weight measurements were done weekly. The antioxidant and hematological parameters were determined using standard techniques and procedures. After careful analyses of data using ANOVA for Antioxidant and hematological parameters, t-test for weight analysis, the results showed that the control group had a non-significantly higher SOD activity (p value=0.65) than the experimental groups. Almost all the experimental groups had a significantly lower Catalase activity (p value =0.04), compared to the control group. There was a non-significant lower MDA level (p value=0.79) in most of the experimental groups. The hematological tests showed that there was no significant increase in WBC level in all the experimental groups compared to the control (p value= 0.43), though the 10% mixture had a higher WBC level. There was a significantly reduced hemoglobin count, hematocrit and RBC count in most of the experimental groups when compared to the control (RBC p value=0.01). There was also a non-significant non-concentration dependent increase in platelet count in most of the experimental groups especially group G (10% mixture of both plants) (p value=0.32). There was also an observed reduction in weight in most of the experimental groups. It can therefore, be concluded that both plants possess antioxidant properties. They may however, have negative effects on hematological indices and may as well, have anti-obesity effects, especially when taken at high concentrations.

**Keywords:** *Curcuma longa; Mentha piperita*; Antioxidants; Super oxide dismutase; Catalase; Malondialdehyde

## 1. Introduction

Turmeric, (*Curcuma longa*) also known as the "golden spice" is a member of the ginger family, Zingaberaceae (Denre, 2014). In traditional medicine, turmeric has been used for its medicinal properties for various indications and through different routes of administration, including topically, orally, and by inhalation. In Nigeria, turmeric is called *atale pupa* in Yoruba, *gangamau* in Hausa, *nwandnmo* in Igbo (Victor-Aduloju *et al.*, 2020). Turmeric is used to produce the vibrant yellow spice used in dishes. *Mentha piperita* L. (peppermint) on the other hand, is a sterile hybrid of the species *M. aquatica L* and *M. spicata.* It is probably the most important commercial aromatic herb in the world today. The Peppermint leaves have a characteristic sweetish, strong odor and an aromatic, warm, pungent taste, with a cooling

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after taste. Pharmacological investigations have demonstrated *that M.piperita* possesses analgesic, antifungal (Saharkhiz *et al.,*2012), antibacterial (Goudjil *et al.,* 2015), antiparasitic and immune modulatory activities (Dejani *et al.,* 2014). Both plants have been used traditionally as local infusions for weight reduction and management (Ajay *et al*., 2024).

In southeastern Nigeria, the plants are generally used especially by young women as herbal agents to reduce weight, especially to shed postpartum weight gain. The plants have been reported to help manage health problems such as arthritis, rheumatism, diabetes, infertility issues and hormonal imbalance as result of their weight reduction properties.

Owing to the fact that these plants are commonly used and reported in various journals in recent times for the prevention, treatment and management of various ailments, it is pertinent to study their antioxidant, hematological and weight reduction effects in other to understand their biological effects in the body, vis-à-vis their acclaimed pharmacological properties.

The aim of this study was therefore to determine the antioxidant, hematological and anti-obesity effects of these plants in wistar rats.

## 2. Materials and methods

### 2.1. Sample collection and preparation

Turmeric rhizhomes *(Curcuma longa)* and Peppermint leaves *(Mentha piperita)* were bought from Eke Awka Market, Anambra state. The plant materials were properly identified by a Taxonomist in the Botany Department of Nnamdi Azikiwe University, Awka. Tumeric was given a herbarium number NAUH-21 while pepper mint leaf was assigned a herbarium number NAUH-220B. Thereafter, the rhizhome and leaves of the plants were washed under running tap water, shade dried at room temperature and ground into fine powder differently. Three portions were obtained, Tumeric alone, Peppermint leaves alone and a mixture of both plants in the ratio 1:1.

### 2.2. Animals

Forty-two Adult Wistar rats comprising of equal numbers of males and Non-pregnant females, were bought from Ken's Animal House, Awka (Affliated to University of Nigeria, Nsukka, Enugu state). They were allowed to acclimatize, the initial weights were taken, they were fed for six weeks, weighed every week, after which they were sacrificed for antioxidant enzyme studies and hematological studies. The animals were handled according to the guidelines set by the Nnamdi Azikiwe University Animal ethics committee, which gave consent for the experiment.

- **Group A (Normal Control group):** Rats were fed with commercial rat pellets. Each rat was fed 15g of commercial rat pellets daily, the quantity was increased or decreased, depending on their spillover.
- **Group B (Experimental group)**: Rats were fed with commercial rat pellets mixed with 2.5% turmeric.
- **Group C (Experimental group):** Rats were fed with commercial rat pellets mixed with 10% turmeric
- **Group D (Experimental group):** Rats were fed with commercial rat pellets mixed with 2.5% mint leaves.
- **Group E (Experimental group):** Rats were fed with commercial rat pellets mixed with 10% mint leaves.
- **Group F (Experimental group):** Rats were fed with commercial rat pellets and a mixture of 2.5% (1:1) of *Curcuma longa* and *Mentha piperita.*
- **Group G (Experimental group):** Rats were fed with commercial rat pellets and a mixture of 10% (1:1) of *Curcuma longa* and *Mentha piperita.*

### 2.3. Reagents and chemicals

All reagents/chemicals, distilled water used, were of analytical standard.

### 2.4. Antioxidant and Hematological studies

The serum antioxidant parameters such as Super oxide dismutase (SOD), Catalase and Lipid peroxidation were analysed using Randox test kits according the manufacturer's instructions and procedures of Sun and Zigma (1978), Singha (1972) and Varshney and Kale (1990) respectively. A Bench top Spectrophotometer was used for the analyses. Hematological analyses were carried out in the laboratory of Applied Biochemistry department, Nnamdi Azikiwe University, using approved standards and techniques.

## 2.5. Assay of Super oxide dismutase (SOD) Activity

***Principle:*** Superoxide dismutase activity was determined by its ability to inhibit the auto-oxidation of epinephrine determined by the increase in absorbance at 480nm as described by Sun and Zigma (1978).

The reaction mixture (3ml) containing 2.95ml 0.05M sodium carbonate buffer (pH 10.2), 0.02ml of the preserved serum and 0.03ml of 2mM epinephrine in 0.005N HCl was used to initiate the reaction. The reference cuvette contained 2.95ml buffer, 0.03ml of substrate (epinephrine) and 0.02ml of water. The absorbance was read at regular interval of 1 min for 5 min at 480nm.

The SOD activity (U/mg Protein) was obtained from the expression:

$$\text{SOD Activity} = \Delta A/\text{min} \times TV/\varepsilon \times SV$$

Where;

$\Delta A$ = change in absorbance

TV = total volume

SV = sample volume

$\varepsilon$ = molar extinction ($40M^{-1}cm^{-1}$)

## 2.6. Assay of catalase activity

***Principle:*** The principle was to measure the catalase degradation of hydrogen peroxide in a mixture containing the serum.

***Procedure:*** Catalase activity was assayed according to the procedure reported by Singha (1972). The reaction mixture (1.5ml) containing 1.0ml of 0.01M phosphate buffer (pH 7.0) and 0.4ml of 0.02M Hydrogen peroxide ($H_2O_2$) solution, was added 0.1ml of the preserved serum. The reaction was stopped by the addition of 2.0ml of dichromate-acetic reagent (5% potassium dichromate and glacial acetic acid mixed in 1:3 ratios). The absorbance was read at regular interval of 1 min at 620nm against reagent blank.

***Calculation:*** The catalase activity (U/mg Protein) was obtained from the expression:

$$CAT = \Delta A/\text{min} \times TV/\varepsilon \times SV$$

Where
$\Delta A$ = change in absorbance
TV = total volume
SV = sample volume
$\varepsilon$ = molar extinction ($40M^{-1}cm^{-1}$)

### *2.6.1. Assay of lipid peroxidation*

The lipid peroxidation (Malondialdehyde, MDA) was determined by the thiobarbituric acid-reacting substances (TBARS) assay method of Varshney and Kale (1990). The reaction principle depends on the formation of a complex between malondialehyde and thiobarbituric acid (TBA).

### *2.6.2. Procedure:*

Exactly 500µl of serum were collected into the test tubes; 1.6ml of 0.25N HCl were added together with 0.5ml of 15% trichloroacetic acid and 0.5ml of 0.375% of thiobarbituric acid and then mixed thoroughly.
The reaction mixture was placed in 100$^{o}$C boiling water for 15 minutes, allowed to cool and centrifuged at 3000 rpm for 10 minutes. The supernatant was collected and the optical density recorded at 532nm against reagent blank containing distilled water.

The lipid peroxidation activity was calculated using the formula:

$$\frac{\text{Optical density}}{Time} \times \frac{\text{extinction co} - \text{efficient}}{\text{amount of sample}}$$

Where the extinction coefficient value is $1.56 \times 10^{-5} M^{-1} CM^{-1}$
The unit is expressed as mg/L of protein.

## 3. Results

All data were Statistical compared between different experimental groups using one-way analysis of variance (ANOVA). Differences between values were considered statistically significant at the $p < 0.05$ level. All values were expressed as mean ± SD. The student t-test was also used for weight analysis.

### 3.1. Antioxidant study

The result of the antioxidant assay is shown in table 1. The result showed that the control group had a non-significantly higher SOD activity (p value=0.65) than the experimental groups (B-G). The control group also had significantly higher catalase activity than most of the experimental groups (B-F) (p value =0.04). Only the 10% mixture group (group G) had significantly higher catalase activity than the control. A non-significant increase in MDA (p value=0.79) in all the experimental groups (B-G) was observed as well.

**Table 1** Average antioxidant and lipid peroxidation indices in the various groups.

| Groups | Super oxide dismutase Activity (µmol/min) | Catalase Activity (µmol/min) | Malondialdehyde concentration (µmol/ml) |
|---|---|---|---|
| A Normal control | $1.41\times10^{-3}\pm3.42\times10^{-5}$ | 0.53±0.05 | $2.44\times10^{-8}\pm1.00\times10^{-9}$ |
| B 2.5% Turmeric | $8.58\times10^{-5}\pm3.80\times10^{-5}$ | 0.42±0.04 | $2.44\times10^{-8}\pm6.32\times10^{-10}$ |
| C 10.0% Turmeric | $8.96\times10^{-5}\pm3.46\times10^{-5}$ | 0.51±0.01 | $2.37\times10^{-8}\pm3.66\times10^{-10}$ |
| D 2.5% Mint leaves | $9.08\times10^{-5}\pm2.02\times10^{-5}$ | 0.50±0.02 | $2.42\times10^{-8}\pm6.87\times10^{-10}$ |
| E 10.0% Mint leaves | $9.33\times10^{-5}\pm1.87\times10^{-5}$ | 0.44±0.06 | $2.40\times10^{-8}\pm1.20\times10^{-9}$ |
| F 2.5% mixture | $7.96\times10^{-5}\pm1.15\times10^{-5}$ | 0.49±0.03 | $2.29\times10^{-8}\pm4.24\times10^{-10}$ |
| G 10.0% mixture | $6.22\times10^{-5}\pm7.18\times10^{-6}$ | 0.60±0.01 | $2.35\times10^{-8}\pm4.13\times10^{-10}$ |

### 3.2. Hematological study

The hematological tests are shown in table 2. The results showed that there was no significant increase in WBC level when all the experimental groups were compared with the control (p-value=0.43), though the 10% mixture had a higher WBC level. There was a significantly reduced hemoglobin count, hematocrit and RBC count in most of the experimental groups when compared with the control (RBC, p value=0.01). There was also a non-significant non-concentration dependent increase in platelet count in the experimental groups (B-G) (p value=0.32) compared to the control.

**Table 2** Average hematological indices in the various groups

| Groups | White blood cell count ($\times10^9$/L) | Red blood cell count ($\times10^{12}$/L) | Hemoglobin count (g/dl) | Hematocrit (%) | Mean corpuscular volume (fL) | Platelet count ($\times10^9$/L) |
|---|---|---|---|---|---|---|
| A.Normal control | 5.77±0.89 | 7.54±0.13 | 14.73±0.09 | 51.03±0.64 | 67.63±1.83 | 454.33±129.63 |
| B. 2.5% Turmeric | 5.67±0.22 | 6.61±0.35 | 12.40±0.64 | 43.40±2.87 | 65.57±1.25 | 591.67±113.90 |
| C. 10.0% Turmeric | 6.05±2.75 | 7.22±0.24 | 13.53±0.43 | 44.23±1.10 | 61.33±1.59 | 535.00±38.37 |

| | | | | | | |
|---|---|---|---|---|---|---|
| D. 2.5% Mint leaves | 6.37±2.11 | 5.98±0.15 | 12.07±0.22 | 41.17±1.36 | 68.80±0.53 | 470.33±86.60 |
| E. 10.0% Mint leaves | 5.40±1.99 | 7.40±0.36 | 14.17±0.55 | 48.07±2.17 | 64.97±1.42 | 378.33±54.87 |
| F. 2.5% mixture | 5.63±1.00 | 7.57±0.35 | 14.27±0.58 | 47.80±1.64 | 63.23±0.89 | 536.33±49.79 |
| G. 10.0% | 9.63±0.78 | 7.10±0.01 | 13.37±0.32 | 50.13±7.79 | 59.10±0.83 | 731.67±157.49 |
| Mixture | | | | | | |

### 3.3. Weight measurement

The weight measurement and analysis are shown in tables 3 and 4. The result shows that there was a reduction in weight in most of the experimental groups except the normal control and 2.5% turmeric groups, where there was weight increase (groups A and B). The 10% turmeric group (groups C) showed a 17% reduction in weight (table 4), when the initial weight was compared with the final weight. This shows that turmeric consumption could reduce weight at a high concentration. Generally, mint leaves have a greater potential to reduce body weight since they do so at a lower concentration (2.5% mint leaves: 10.95% reduction). In some of the groups like 10% turmeric and 2.5% mint leaves groups (groups C and D), there were significant reductions in weight, while there were significant increases in weight in the 2.5% Turmeric and normal control groups (B and A).

**Table 3** Average weight (g) of the various rat groups

| Groups | 1 | 2 | 3 | 4 | 5 | 6 (weeks) |
|---|---|---|---|---|---|---|
| Normal control(group A) | 96.95±8.56 | 110.05±9.66 | 122.10±9.69 | 104.52±8.26 | 127.52±10.43 | 113.00±9.09 |
| 2.5% Turmeric(group B) | 88.75±5.15 | 100.67±5.77 | 107.08±7.15 | 92.24±6.92 | 111.94±8.01 | 101.50±6.73 |
| 10% Turmeric(group C) | 152.88±8.18 | 156.27±7.92 | 149.74±8.23 | 136.00±8.47 | 136.30±10.53 | 125.60±7.78 |
| 2.5% Mint leaves(group D) | 113.42±6.83 | 107.06±6.70 | 107.42±7.16 | 104.26±6.00 | 98.87±5.55 | 101.00±5.32 |
| 10% Mint leaves(group E) | 111.85±15.50 | 110.25±15.60 | 142.77±15.97 | 125.29±14.83 | 133.65±15.43 | 110.60±11.58 |
| 2.5% Mixture(group F) | 97.48±4.57 | 106.17±4.87 | 94.61±4.83 | 107.25±5.35 | 103.21±5.64 | 90.17±6.73 |
| 10% Mixture(group G) | 170.78±9.09 | 159.34±11.55 | 175.05±9.07 | 157.65±8.57 | 154.72±8.60 | 150.25±10.38 |

**Table 4** Percentage change in weight during the experimental period

| | 1 | 2 | 3 | 4 | 5 | 6(weeks) |
|---|---|---|---|---|---|---|
| Normal control | 0 | 13.50891 | 25.94681 | 7.805876 | 31.53192 | 16.55693 |
| 2.5% Turmeric | 0 | 13.44113 | 20.66407 | 3.934494 | 26.13105 | 14.37264 |
| 10% Turmeric | 0 | 2.213016 | -2.05603 | -11.0422 | -10.8484 | -17.8459 |
| 2.5% Mint leaves | 0 | -5.60592 | -5.29293 | -8.07606 | -12.8341 | -10.9518 |
| 10% Mint leaves | 0 | -1.42757 | 27.6463 | 12.0211 | 19.49394 | -1.11315 |
| 2.5% Mixture | 0 | 8.911077 | -2.94585 | 10.02411 | 5.876319 | -7.50398 |
| 10% mixture | 0 | -6.69881 | 2.499366 | -7.68548 | -9.40019 | -12.0196 |

## 4. Discussions

Super oxide dismutase (SOD) constitutes a very important antioxidant defense against oxidative stress in the body. They form the front line of defense against Reactive oxygen species (ROS). Catalase are proteins also involved in protecting the cell against reactive oxygen species, by regulating the cellular level of hydrogen peroxide. Malondialdehyde (MDA), results from lipid peroxidation, its production is used as a biomarker to measure the level of oxidative stress in an organism (Collin, 2019). From the result shown in table 1, Groups B and C (2.5% and 10% turmeric supplement) had non-significant lower SOD activity (p value=0.65), a significant lower catalase activity (p value =0.04) plus a non-significant lower MDA level (p value=0.79) in group C compared to the control. The lower level of activities of the endogenous antioxidant enzymes (SOD and Catalase) in these groups, compared to the control group, showed that the animals in these groups had lower free radicals. The rich phytochemicals such as flavonnoids, anthocyannins, saponinns and tannins, vitamins such as vitamins A, E and C found in turmeric (Anyaoku *et al*, 2023), act as exogenous antioxidants to mop up free radicals, thus reducing oxidative stress in these animals, resulting in less demand for the endogenous antioxidants (SOD and Catalase) hence their recorded lower activites in these group. The observed lower level of lipid peroxidation evidenced by the lower MDA level in group C (10% turmeric) supports the antioxidants effects of Turmeric, most likely because of its numerous phytochemicals and vitamin content as already stated. Tumeric antioxidant benefits seem to be more pronounced with increase in concentration as seen in the lower MDA level in group C (10% Turmeric supplement). A similar study done by Obinna and Ajibo, 2022, showed that turmeric has invivo antioxidant activity by reducing serum MDA level. This is in accordance with the findings of this study. However, a study done by Ibrahim *et al*., 2020, demonstrated that "curcuminoid", an isolate from Turmeric, increased the serum antioxidative defence capacities (SOD, reduce glutathione and catalase). Curcumoid, isolated from turmeric is known to possess antioxidant effect, it may be able to boost the activities of SOD and catalase (Amirhossein and Macie, 2015). One mechanism for the antioxidant actions of curcumoids is modulation of the activities of glutathione, peroxidase, catalase and SOD, which are enzymes that are active in the neutralization of free radicals (Marchiani, *et al*., 2014). The study done by Ibrahim *et al*., 2020 showed an increase in the serum antioxidants, unlike the result from this present study which showed lower activities of the serum antioxidants (SOD and Catalase). This might be because the former study used only an isolate of turmeric "curcuminoid", which is devoid of numerous phytochemicals and vitamins which may act as exogenous antioxidants helping to mop up free radicals, thus lowering the demand/activities of endogenous antioxidants (SOD and Catalase).

Groups D and E (2.5% and 10% pepper mint leaves) also had a non-significant lower SOD activity, a significant lower catalase activity and a non-significant lower MDA level compared to the control group (table 1). This shows the antioxidant property of Pepper mint leaves. The myriad of phytochemicals and vitamins found in Pepper mint leaves (Anyaoku *et al*., 2023) might be responsible for the observed lower activities of the serum antioxidants. These phytochemicals and vitamins help to reduce the level of free radicals in the body, thus lowering the demand for the serum endogenous antioxidants as well as reducing their activities. The reduced level of lipid peroxidation as seen in the lower level of MDA in these groups shows the antioxidant capacity of Pepper mint leaves. A study done by Bellassoued *et al*., 2018, showed that Pepper mint essential oil, reduced kidney peroxidation and increased the activities of antioxidant enzymes, hence supporting the antioxidant effect of pepper mint leaves. The increased activities of the antioxidants enzymes in the study done by Bellassoued *et al*., 2018 might be attributed to the fact that only the extracted oil was used in the experiment, while the lower activities of the antioxidant enzymes observed in this study might be because of the use of the whole leaves without any form of extraction. The leaves contain higher concentration of phytochemicals and vitamins that will help to fight oxidative stress, hence reducing the need/activities of the serum endogenous antioxidants (SOD and Catalase).

The last group that took a mixture of both plants (turmeric and pepper mint leaves) at 2.5% and 10% concentrations (Groups F and G) also had a non-significant lower SOD, a non-significant lower MDA levels and a significant lower catalase activity only in group F compared to the control group (table 1). This implies that taking both plants as a mixture also helped in reducing oxidative stress evidenced by the observed lower lipid peroxidation (lower MDA levels) in both groups. As already discussed, Turmeric and Pepper mint leaves contain various phytochemicals, vitamins and minerals which contribute to the antioxidant properties of both plants. The lower serum endogenous antioxidant activities seen in these groups might be as a result of lower level of free radicals in these animals as a result of the antioxidant activities of the phytochemicals, vitamins as well as minerals found in these plants.

The result shown in table 2, revealed that group B (2.5 % turmeric) had lower non-signigicant WBC level (p value= 0.43) compared to the control, both groups B and C (2.5% and 10% turmeric) had a significant lower RBC count, Hemoglobin levels and MCV levels (RBC p value=0.01). They also had non-significant lower hematocrit level and higher platelet count, compared to the control group (p>0.05). This shows that Turmeric rhizome has the ability to reduce red blood cell production. This may be attributed to its Tannin content, as well as some other antinutrients which bind to iron in diet, preventing its absorption in the intestine (Delimont *et al*., 2017). Lower levels of iron can lead to lower levels of hemoglobin. The poor absorption of certain nutrients from the intestine can also lead to lower levels of white blood cell production as seen in group B. The non-significant higher platelet count in groups B and C (p value=0.32), may be as a result of an ongoing inflammation. The study done by Iwueke *et al*., 2020, also reported an increased platelet count and reduced white blood cells (WBC) and packed cell volume (PCV) concentrations in Turmeric fed male albino rats, thus supporting the findings of this study.

Similarly, groups D and E (2.5 % and 10% pepper mint leaves) had a significant lower RBC count and hemoglobin level, a non-significant hematocrit level compared to the control. Group D had higher WBC count, while group E had lower WBC count compared to the control. Both groups had non-significant lower platelet count (table 2) compared to the control. This shows that pepper mint leaves also have the ability to reduce erythropoiesis and hematopoiesis if consumed for a long period of time as seen in the significant lower RBC count and hemoglobin levels, in addition to the non-significant lower platelet count in these groups (table 2). The antinutrients found in Pepper mint leaves may as well, prevent nutrient absorption in the intestine especially iron, thus reducing hematopoiesis. Higher concentration of Pepper mint leaves may have more serious impact in blood cells production as seen in the lower WBC count and platelet count in the groups that took 10% pepper mint leaves (group E). Groups F and G (2.5% and 10% mixture of turmeric and pepper mint leaves) also had non-significant lower WBC count, significant lower RBC count in group G alone, a significant lower hemoglobin and hematogrit levels in both groups, a non-significant lower MCV values and a non-significant lower platelet count in both groups (table 2). This shows that a mixture of the two plants also have the ability to reduce erythropoiesis and hematopoiesis as seen in the significant lower RBC in group G and a significant lower hemoglobin and hematogrit levels in both groups. The antinutrients such as tannin and saponin in both Turmeric and Pepper mint leaves may be responsible for the lower level of blood cells in these groups as already elucidated. The higher platelet count observed in these groups, compared to the control, may be pointing to an on-going inflammation or tissue injury. The group that took 10% mixture of both plants (group G) had the highest platelet count in the entire treatment groups.

The weight measurement and analysis from table 3 and 4, showed that there was reduction in weight in most of the experimental groups except in groups A and B (2.5% turmeric and normal control respectively), which had increase in weight. It was observed that group D animals had a surprising increase in weight between weeks 2 to 3 (110.25g-142.77g), which later dropped in subsequent weeks. This might be because the animals over consumed the feeds in the second week of the experiment, which was their first time of taking the feeds. Their appetite must have been badly affected in the subsequent weeks, which lead to reduced consumption and consequently led to reduced weights. It can be inferred that these plant samples (turmeric and mint leaves) could serve as weight reducing agents (anti-obesity agents). The 10% turmeric group (group C) showed a 17% reduction in weight, when the initial weight was compared with the final weight (table 4). This shows that Turmeric consumption could reduce weight at a high concentration. Pepper mint leaves on the other hand, seems to have greater potential to reduce body weight since they caused a 10.95% weight reduction in group D (2.5% mint leaves) which had lower concentration of Peppermint (table 4). In some of the groups like groups C and D (10% Turmeric and 2.5% mint leaves), there were significant weight reduction, while there were significant increases in weight in groups A and B (Normal control and 2.5% Turmeric groups) (table 3 and 4). The groups that consumed a mixture of both plants (groups F and G) also had 7% and 12% weight loss respectively (table 4). This result is in agreement with the study done by Yang and Lee, 2011 which reported that fermented Turmeric extracts might be effective in preventing obesity in rats fed with high fat diet. According to Budiman *et al*., 2015, *Curcuma* *longa* (Turmeric) extract, possesses anti-adipogenesis potential in inhibiting the synthesis of triglycerides, cholesterol and lipid formation in HepG2 cell and has anti-obesity parameters better than curcumin. In another study done by Han *et al*., 2016, Turmeric was reported to reduce obesity in rats fed with high fat diet.

Some studies carried out on Pepper mint leaves also supported the weight reduction potential of the plant. Barbalho *et al*., 2009 for example, reported that *M. piperita* (Pepper mint leaves) caused reduction in weight gain in rats as well as their food intake. In contrast, Rahmat *et al*., 2013, reported an increased food intake and body weight in mice fed with Peppermint oil extract after an immobilization stress. This report is a deviation from the result gotten from this current study. The reason might be attributed to the oil extract used, which is likely to contain very little concentration of phytochemicals compared to the leaves. Besides, Oils/lipids also have the tendency to increase body weights.

The weight reduction properties of turmeric and pepper mint leaves as observed in this study (table 3 and 4), may be attributed to their rich phytochemical contents (Anyaoku *et al*.,2023). Reduced blood volume, appetite, food intake and malabsorption of nutrients in the GIT caused by tannin may contribute to the weight reduction. The observed weight reduction caused by intake of turmeric and pepper mint might also be related to the lower RBC count, hemoglobin and hemocrit levels (table 2) observed in this study. Phytochemicals abundant in these plants, particularly saponin and tannin (Anyaoku *et al*.,2023) may be responsible for these properties. In addition, Flavonoids in Turmeric and Peppermint also have anti-hyperlipidemic and anti-inflammatory effects. They may have the potential in reducing cholesterol and HDL-C (Othman *et al*., 2011). Tumeric and Peppermint leaves at low concentrations may serve as dietary agents in the prevention and treatment of hyperlipidemia, but never as a replacement/substitute for medically approved drugs for patients suffering from hyperlipidemia.

This study validates the reason and claims why Turmeric and Peppermint leaves are used by many people, especially young women in Southern and Eastern Nigeria for weight reduction and maintenance. However, from the result of this study, caution is required when taking these plants as anti-obesity agents. High concentrations of each sample or a mixture of the two samples may increase the level of these phytochemicals in the body, which may have deleterious effects as already discussed. Pepper mint and turmeric can be taken at low concentrations over a short period of time. The elderly, the sick, the malnourished, children and pregnant women should be careful in taking high concentrations of these plants or a mixture of both to avoid the side effects associated with these plants.

## 5. Conclusion

Both plants have antioxidant properties. They may help to mop up free radicals in the body. The plants' phytochemical, vitamin and mineral contents might be responsible for the antioxidant properties. However, they may have negative effects in blood cells production, and may cause anaemia, if consumed in high concentrations or used as a cocktail. The plants also have anti-obesity effects, but should not be used as replacements/substitutes for medically approved drugs for patients suffering from hyperlipidemia or be used consistently as weight reduction agents. It is advised that both plants should be used individually and in moderation.

## Compliance with ethical standards

This research work was done with the approval of Nnamdi Azikiwe University's animal ethics committee. All instructions and rules of the committee were duly adhered to.

### *Disclosure of conflict of interest*

The authors declare that there are no conflicts of interest

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