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Antioxidant and haematological potentials of fruit wastes from *Terminalia catappa* and observable trophic effect on weight of wistar rats after exposure to monosodium glutamate

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ABSTRACT

This study investigated the antioxidant and haematological potentials of a fruit wastes from *Terminalia catappa* and observable trophic effect on weight of Wistar rats after acute exposure to monosodium glutamate. Twenty-four male albino Wistar rats with mean weight of 120.61±15.15 g were divided into six groups (n=4). Group 1, the normal control (received distilled water), group II, the negative control (received 8mg MSG/g b.wt), group III, the extract control (received 300 mg extract/kg b.wt), group IV (received 8 mg MSG/g b.wt. + 100 mg extract/kg b.wt.), group V (received 8 mg MSG/g b.wt. + 300 mg kg-1 b.wt. extract) and group VI (received 8 mg MSG/g b.wt. + 500 mg extract/kg b.wt). Treatment was administered daily by oral gavage for 14 days. Data were subjected to one-way ANOVA followed by Duncan *post-hoc* test at $p<0.05$ and means were estimated and significant differences noted. DPPH antioxidant assay for the fruit wastes ethanol extract of *Terminalia catappa* endocarp revealed the extract produced 92.8% inhibition which is comparable to 96.07% inhibition produced by ascorbic acid at the same concentration, as well as, possessed FRAP activity in a concentration dependent manner. *In vivo* antioxidant assays carried out revealed that the superoxide dismutase (SOD) activity was significantly ($p<0.05$) lowered in the MSG-treated group but the catalase (CAT) activity showed a non-significant decrease as compared to the normal control, confirming there was oxidative stress. However, treatment with the extract increased the activities of SOD and CAT perhaps due to the presence of phenolic and flavonoids components. There was a significant ($p<0.05$) increase in WBC and RBC and could be attributed to the potential of the extract to stimulate the immune system. Haemoglobin (Hb) and packed cell volume (PCV) in MSG-extract co-administered rats showed a positive ameliorative effect of the extract in a dose dependent manner when compared to MSG group. Weight gain following extract administration was not dose dependent. The results showed that the fruit wastes had antioxidant potency and haematological potential. This bio-approach is promising as it solves the problem of environmental burden, as well as, serves economic benefits and hence, may become increasingly attractive.

Keywords: *Terminalia catappa*, MSG-intoxication, Agro-wastes (fruit wastes), Antioxidant.

INTRODUCTION

Agro-wastes often referred to as agricultural waste are residues from the processing of raw agricultural products such as fruits, vegetables, crops, dairy products etc. Agro-waste is comprised of food processing waste (only 20% of maize is canned and 80% is waste), crop waste (corn stalks, sugarcane bagasse, drops and culls from fruits and vegetables, prunings), animal waste (manure, animal carcasses) and toxic agricultural waste such as pesticides, insecticides and herbicides etc. [1]. Generally, they may contain materials that can benefit man but whose economic values are less than the cost of tapping and processing them for beneficial use. However, agro-wastes are thought to have a toxicity potential to plant, animals and human through many direct and indirect channels. Fruits and vegetable wastes are one of the chief sources of municipal waste [2] which poses an environmental problem. For instance, it is a source of greenhouse gases which is a significant contributor to climate change. *Terminalia catappa* L. is a Combretaceous plant whose leaves are widely used as a folk medicine in Southeast Asia. It is a multipurpose plant whose roots, stems, leaves and fruit have been widely used throughout the tropics for medicinal, ornamental, shade and nutritional (edible nuts) purposes, while the shell of the fruit is usually discharged or not utilized [3]. Studies have revealed that the root, leaf, seed, bark, fruit contain various phytochemical compounds believed to have diverse pharmacological effects [3, 4].

Over the years, the use and possible abuse of food additives is rampant with a seeming disregard of the associated health risks by the public [5, 6]. Sodium salt of glutamate (MSG) is one of the most popular

food additive, flavor enhancer used by various food industries [7, 8]. Its consumption has increased worldwide owing to its flavor enhancing capability [9]. However, its use as a flavor has been challenged due to a number of reports describing its toxic effects in humans, as manifested by the Chinese restaurant syndrome [10, 11] characterized by headache, burning sensation along the back of the neck, chest tightness, stomach ache, weakness, diarrhea, nausea and sweating [12]. However, people consume large doses of monosodium glutamate [13] with possible adverse effects that could be due to increased physiological concentration of the dissociation products of monosodium glutamate-glutamate and sodium ions. Thus, exploring the potential of fruit wastes as natural resources of bioactive compounds could reduce its attendant environmental burden-related health implications while beneficially they could play protective roles in biological systems.

MATERIALS AND METHODS

Plant Materials and Authentication

Fruits of *Terminalia catappa* were harvested from College of Pure and Applied Sciences (COLPAS) of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The plant was identified and authenticated by Mr. N. Ibe of Forestry and Environmental Management, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

Preparation of plant materials

The fresh ripe fruits of *Terminalia catappa* were washed, peeled (to remove the edible ectocarp), air dried at room temperature (to remove excess moisture), deshelled and the resultant shell (endocarp) milled to powder and stored in an air tight container. The ethanol extract was prepared by soaking 250 g of *Terminalia catappa* endocarp flour in 1 L of 95% ethanol for 72 h at room temperature with rigorous shaking. The mixture was filtered with Whatman filter paper No. 1. The filtrate was then dried at a temperature of 50 ºC in oven and stored in refrigerator for further use and percentage yield was calculated.

Animal studies

A total of 24 Wistar rats (male) having mean body weight of 120.61±15.15g were used in this experiment. Rats were bought from the animal house of University of Nigeria, Nsukka and housed in animal cage in the animal house of Department of Biochemistry, College of Natural Sciences, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. After 7 days of acclimatization, they were equally divided into 6 groups of 4 rats each according to their weight in a completely randomized design. This study was carried out in accordance with ethical guidelines for animal welfare as approved by Biochemistry Department, College of Natural Sciences, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Rats in Group 1 (the control) were given only distilled water, Rats in group 2 were given only MSG (8mg/g) while rats in group 3 received only the ethanol extract (300mg/kg b.wt.) of *Terminalia catappa* milled endocarp. On the other hand, rats in Groups 4, 5 and 6 were co-treated with MSG (8mg/g b.wt.) and extract (100mg/kg, 300mg/kg and 500mg/kg b.wt.) respectively. The doses were calculated and adjusted based on the WHO recommended daily oral intake for an average person of 70kg. Exposure was per oral and lasted for 14 consecutive days.

Blood collection and preparation

At the end of experiment, the rats were anaesthetized in chloroform chamber, sacrificed and blood sample obtained by cardiac puncture using sterile plain tubes for in vivo antioxidant assays while EDTA capillary tubes were used to collect blood for haematological analyses.

In vitro antioxidant assays

2,2-Diphenyl-1,1-picrylhydrazyl (DPPH) photometric assay: The free radical scavenging activity of the extract was determined by the DPPH Assay method described by [14]. The assay is based on the measurement of the scavenging capacity of antioxidants (present in the extract) towards a stable free radical, α,α-diphenyl-β-picrylhydrazyl (DPPH; $C_{18}H_{12}N_5O_6$, $M = 394.33$). The odd electron of nitrogen atom in DPPH is reduced by receiving a hydrogen atom from antioxidants to the corresponding hydrazine by reading the absorbance at 517nm**.** The percentage antioxidant activities were calculated as follows:

$$\% \text{ Antioxidant activity (AA)} = \frac{\text{100-(ABS sample—ABS blank)}}{\text{ABS control}} \times \frac{100}{1}$$

Ferric reducing antioxidant power (FRAP) assay: The ferric reducing antioxidant power was carried out as described by [15]. The method is based on the reduction of Fe^{3+} TPTZ complex (colorless complex) to Fe^{2+}-tripyridyltriazine (blue colored complex) formed by the action of electron donating antioxidants present in the plant extract at low pH (3.6). This reaction was monitored by measuring the change in absorbance at 593 nm. The percentage antioxidant activities were calculated as follows:

FRAP value of sample (µMol/L) =

$$\frac{\text{Changes in absorbance of sample from 4min - 0mins}}{\text{Changes in absorbance of STD 4 min - 0 min 1}} \times \text{FRAP value of std (1000 µmol)}$$

In vivo antioxidant assays

Determination of catalase activity: The catalase activity was determined by the method of [16]. The principle of this method is based on splitting/decomposition of hydrogen peroxide by catalase. At specific time interval, the reaction was stopped by the addition of dichromate/acetic acid reagent. When heated in the presence of hydrogen peroxide, dichromate in acetic acid was reduced to chromic acetate and an unstable perchromic intermediate. The remaining hydrogen peroxide was determined by measuring the chromic acetate formed by a wavelength of 610nm. The activity of the catalase was determined by the amount of hydrogen peroxide consumed, expressed in µmoles of H_2O_2 consumed/minute/mL.

Determination of superoxide dismutase (SOD) activity: The method of auto-oxidation by pyrogallol was used as described by [17]. This is based on the principle that pyrogallol is auto-oxidized rapidly in alkaline solution generating superoxide ions. Superoxide dismutase inhibits its auto-oxidation, dismutating the superoxide ions to hydrogen peroxide and molecular oxygen. The activity of 50% inhibition by SOD was measured at 450nm.

Haematological assay

Determination of erythrocyte count by haemocytometry: The erythrocyte count was determined by the method of [18]. The blood specimen was diluted 1:200 with RBC diluting fluid and cells were counted under high power (40X) objective by using a counting chamber. The number of cells was calculated and reported as the number of red cells/cu.mm of whole blood.

Determination of total leucocyte count by haemocytometry: The total leucocyte count was determined by haemocytometry following the method described by [18]. The glacial acetic acid lysed the red cells while the gentian violet slightly stained the nuclei of the leucocyte. The blood specimen was diluted 1:20 in a WBC pipette with the diluting fluid and the cells were counted under low power microscope by using a counting chamber. The number of cells in undiluted blood was reported as the number of white cells/cu.mm of whole blood.

Determination of packed cell volume (PCV): PCV was estimated as described by [18]. Blood sample was taken with a heparinised capillary tube, cleaned and sealed with plasticine. The filled tubes were placed in the microhaematocrit centrifuge and spun at 12,000 g for 5 minutes. Spunned tubes were placed into a specially designed scale and the PCV was read as a percentage.

$$PCV\ (\%) = \frac{\text{Packed RBC column height}}{\text{Total blood volume height}} \times 100$$

Determination of haemoglobin (Hb) concentration

Haemoglobin concentration was determined by the cyanomethaemoglobin method as described by [18]. The hemoglobin is mixed with Drabkin's solution which contains potassium ferricyanide, potassium cyanide and potassium dihydrogen phosphate. The ferricyanide form methaemoglobin which is converted to cyanomethaemoglobin by the cyanide. The cyanomethaemoglobin produces a colour which is measured using a colorimeter at 540nm.

Calculation:

Grams of haemoglobin per 100 mL of blood = $\frac{\text{Absorbance of test}}{\text{Absorbance of standard}} \times \text{Dilution factor}$

RESULTS

***In vitro* antioxidant activity in the DPPH and FRAP assays**

As shown in Table 4.1, the ethanol extract of *Terminalia catappa* endocarp flour showed potent concentration dependent antioxidant activity in the DPPH assay. At 400ug/ml concentration, the extract produced 92.8% inhibition which is comparable to 96.07% inhibition produced by ascorbic acid at the same concentration.

Table 4.1: DPPH radical scavenging activity of the ethanol extract of *Terminalia catappa* endocarp flour

	% Inhibition	
Concentration (µg/ml)	***Terminalia catappa* extract %**	**Ascorbic acid (standard) %**
25	10.10±1.49	72.59±5.20
50	20.16±1.80	97.21±0.33
100	39.13±1.53	95.58±0.07
200	68.34±0.70	95.62±0.22
400	92.98±0.30	96.07±0.06

The result of the FRAP assay is presented in Table 4.2. The extract produced concentration dependent ferric reducing antioxidant power. The extract produced its optimum activity at 400 µg/ml.

Table 4.2: Ferric reducing antioxidant power of ethanol extract of *Terminalia catappa* endocarp flour

Concentration (µg/ml)	***T.catappa* extract (µmol/L)**
25	0.31±0.25
50	0.71±0.25
100	1.09±0.05
200	2.53±0.02
400	4.19±0.02

Calibration was done using 2µmol/L of ascorbic acid

Results of the effect of *Terminalia catappa* endocarp ethanol extract (TCEFEE) on oxidative stress markers (catalase and superoxide dismutase) parameters in wistar albino rats are presented in Table 4.3. There was no significant ($p>0.05$) depletion in catalase activity observed in the MSG-alone (group II) and extract-alone (group III) groups of rats compared to those of normal control (group I). Group IV rats showed no significant ($p>0.05$) increase in serum catalase activity when compared to groups I and II while results of the serum superoxide dismutase activity in group II showed a significant ($p<0.05$) decrease when compared to the normal control (group I), the extract group (group III) and the groups co-treated MSG with varying concentrations of the extract (groups IV, V and VI).

Table 4.3: Effect of *Terminalia catappa* endocarp flour ethanol extract (TCEFEE) on oxidative stress markers (catalase and superoxide dismutase) in serum renal indices of normal and MSG-intoxicated wistar rats

Group	**Catalase Activity (U/L)**	**Superoxide Dismutase Activity (U/L)**	**CAT Activity / SOD Activity**
Group I (Normal Control)	2.08±0.88^a	11.12±0.15^a	0.19
Group II (MSG group)	1.77±1.50^a	10.82±0.03^b	0.16
Group III (extract group)	1.81±0.21^a	11.14±0.09^a	0.16
Group IV (MSG+100mg/kg extr.)	2.92±0.57^a	11.35±0.07^a	0.26
Group V (MSG+300mg/kg extr.)	1.74±0.30^a	11.29±0.08^a	0.15
Group VI (MSG+500mg/kg extr.)	2.24±0.39^a	11.25±0.12^a	0.20

Data are mean±S.E.M. (n=4). Mean in the same column with different superscript letters are significantly different, $p<0.05$ (One-Way ANOVA followed by Duncan post-hoc test).

Key: Group I = Normal Control
Group II = Negative Control (MSG-alone treated rats)
Group III = Extract Control (Extract-alone treated rats)
Group IV = MSG + 100mg/kg TCEFEE
Group V = MSG + 300mg/kg TCEFEE
Group VI = MSG + 500mg/kg TCEFEE

Results of the effect of *Terminalia catappa* endocarp ethanol extract (TCEFEE) on haematological parameters in wistar albino rats are presented in Table 4.4. The WBC indices result showed a marked significant ($p<0.05$) decrease in the MSG group (group II) when compared to the normal control (group I). The extract group (group III) was significantly ($p<0.05$) higher than the MSG group (group II) but significantly ($p<0.05$) lower than the normal control (group I). Comparism between MSG treated group (group II) and groups co-treated MSG with varying concentrations of the extract (groups IV, V and VI) showed a significant ($p<0.05$) increase in group IV while group V and VI showed no significant increase in WBC count.

The RBC count of rats treated with MSG alone (group II) was significantly ($p<0.05$) lower compared to those of the normal control (group I). The extract group (group III) showed a marked significant ($p<0.05$) increase in the RBC count compared to the MSG-alone group (group II). Compared to MSG-alone group (group II), group IV showed no significant ($p>0.05$) increase while groups V and VI both showed a significant ($p<0.05$) increase in the RBC count.

The hemoglobin concentration of rats exposed to MSG alone (group II) showed no significant decrease ($p>0.05$) compared to those of the normal control (group I). The extract group (group III) showed a comparative increase compared to both the MSG-alone and normal control groups. Compared to the MSG-alone group, the group co-treated with extract (group IV) showed no significant ($p>0.05$) decrease in hemoglobin concentration. However, groups V and VI showed no significant increase in a dose dependent manner.

The packed cell volume of the animals showed no significant ($p>0.05$) difference in all the treated groups.

Table 4.4: Effect of *Terminalia catappa* endocarp ethanol extract (TCEFEE) on haematological parameters in MSG intoxicated wistar rats

Group	WBCX10²/L	RBC/L	Hb (g/dl)	PCV (%)
Group I (Normal Control)	93.25±3.30[a]	160.00±12.25[a]	16.67±1.10[a]	49.60±2.96[a]
Group II (MSG group)	74.00±8.18[b]	136.25±8.98[b]	15.43±1.46[a]	45.89±4.58[a]
Group III (extract group)	85.00±11.05[b]	162.50±6.29[a]	17.38±1.67[a]	52.18±5.04[a]
Group IV (MSG+100mg/kg extr.)	106.63±2.58[a]	137.50±4.79[b]	13.83±0.34[a]	41.27±1.11[a]
Group V (MSG+300mg/kg extr.)	82.50±11.85[b]	155.00±2.89[a]	16.95±2.37[a]	50.41±7.13[a]
Group VI (MSG+500mg/kg extr.)	75.00±9.47[b]	152.50±6.29[a]	17.12±1.06[a]	51.02±3.13[a]

Data are mean±S.E.M. (n=4). Mean in the same row with different superscript letters are significantly different, $p<0.05$ (One-Way ANOVA followed by Duncan post-hoc test).

Key: Group I = Normal Control
Group II = Negative Control (MSG-alone treated rats)
Group III = Extract Control (Extract-alone treated rats)
Group IV = MSG + 100mg/kg TCEFEE
Group V = MSG + 300mg/kg TCEFEE
Group VI = MSG + 500mg/kg TCEFEE

The results of the effect of *Terminalia catappa* endocarp flour ethanol extract (TCEFEE) on weight of rats are presented in Table 4.5.

As shown in Table 4.5, on the 7th day, body weight of animals in groups II, III, IV, V and VI increased from 117.23, 135.07, 116.18, 94.61, 135.00 to 125.50, 138.50, 125.25, 107.75, 139.25 respectively, thereby denoting 15%, 3%, 8%, 14% and 3.15% increase in weight gain respectively while on the 14th day, 43%, 8%, 4%, 3%, 21% and 2% increase in weight gain were observed.

Table 4.5: Variation in weight of rats (g) treated with *T. catappa* extract

Group	Day 1 (Baseline)	DAY 7	% Weight Gain	DAY 14	% Weight Gain
Group I (Normal Control)	125.56±8.90[a]	162.75±6.76[a]	30	179.25±9.00[a]	43
Group II (MSG group)	117.23±6.79[a]	125.50±3.28[b]	15	126.25±5.23[b]	8
Group III (extract group)	135.07±2.25[a]	138.50±3.66[b]	3	140.25±1.70[b]	4
Group IV (MSG+100mg/kg extr.)	116.18±6.07[b]	125.25±7.55[b]	8	120.00±13.04[b]	3
Group V (MSG+300mg/kg extr.)	94.61±4.56[c]	107.75±3.47[c]	14	114.50±3.01[b]	21
Group VI (MSG+500mg/kg extr.)	135.00±1.00[a]	139.25±15.33[b]	3	137.75±15.30[b]	2

Data are mean±S.E.M. (n=4). Mean in the same row with different superscript letters are significantly different, $p<0.05$ (One-Way ANOVA followed by Duncan post-hoc test)).

Key: Group I = Normal Control
Group II = Negative Control (MSG-alone treated rats)
Group III = Extract Control (Extract-alone treated rats)
Group IV = MSG + 100mg/kg TCEFEE
Group V = MSG + 300mg/kg TCEFEE
Group VI = MSG + 500mg/kg TCEFEE

DISCUSSION

Oxidative stress is a distinguishing feature in a number of neurodegenerative disorders [19]. The liver is susceptible to oxidative stress injury because of high rate of oxidative metabolic activity [20]. It was reported that MSG was associated with the production of oxygen free radicals and oxidative stress in different tissues of experimental animals [21, 22].

Antioxidants play a key role in precluding the formation of free radicals which are responsible for many oxidative processes leading to cell damage [23]. According to [11], to scavenge reactive oxygen species (ROS), different defense system exist such as enzymatic (superoxide dismutase, glutathione peroxidase and catalase), non-enzymatic (glutathione and uric acid) and dietary antioxidants.

According to [24], percentage inhibition and inhibitory concentration (IC_{50}) are parameters used to characterize the potential for radical scavenging activity, where the higher IC_{50} indicate a lower radical scavenging activity (vice versa). DPPH antioxidant assay carried out on the fruit waste extract (*Terminalia catappa* endocarp ethanol extract) in this present study revealed that the extract produced 92.8% inhibition which is comparable to 96.07% inhibition produced by ascorbic acid at the same concentration (400 ug/ml) which implied that the fruit waste extract exerted a potent antioxidant capacity. Although, there is paucity of information in determining the radical scavenging potential of *Terminalia catappa* endocarp flour, several literatures have reported the radical scavenging potency for other parts of the plant which include leaf, ripe and unripe fruit. In a similar study carried out by [24], the fruit extract from both ripe and unripe fruit of *Terminalia catappa* showed higher percentage inhibition when compared with leaf extract. However, his finding is in disagreement with the report of [25] that the leaf extract showed a higher antioxidant capacity than the fruit extract.

The percentage of inhibition values clearly correlates with the presence of phenolic compounds present and reveals the therapeutic antioxidant potentials of the extract [26]. The phenolic compounds serves as hydrogen atom donors to the radical. Hence, the free radicals are neutralized and the oxidative stress eliminated. This implies that fruit waste ethanol extract of *Terminalia catappa* is highlighted to be a worthy source of antioxidant. However, this report is only valid for the studied freshly generated fruit waste of this plant.

Ferric-reducing antioxidant power (FRAP) assay is a direct assay which measures the quantity of antioxidants from the sample or reducing ability of the sample [27]. The result obtained showed that the extract possessed ferric reducing antioxidant activity in a concentration dependent manner. The extract produced its optimum activity at 400 µg/ml concentration. This suggests that the fruit waste ethanol extract of *Terminalia catappa* had the ability of transferring the Fe^{3+} to Fe^{2+}. Thus, could be a good source of antioxidants.

In vivo antioxidant assays carried out revealed that the superoxide dismutase (SOD) activity was significantly ($p<0.05$) lowered in the MSG-treated group but the catalase activity showed a non-significant decrease as compared to the normal control, confirming there was oxidative stress. This result agrees with the report of [28] that oral ingestion of MSG at dose level of 4000mg/kg body weight and above with or without alcohol has been suggested to have increased the oxidative stress by significantly ($p<0.01$) decreasing the superoxide dismutase activity of adult male mice. However, treatment with *Terminalia catappa endocarp ethanol* extract increased the activities of superoxide dismutase and catalase perhaps due to the presence of phenolic and flavonoids components [29]. Flavonoids are polyphenolic substances which are synthesized by plants during stress e.g microbial infection [30, 31]. Functional groups (hydroxyl groups) in flavonoids heighten the antioxidant effects by scavenging free radicals or by contributing an electron of their own to counteract free radicals and help prevent resultant damage to the body cells and tissues [32].

Evaluation of hematological parameters represents an important and relevant risk evaluation as the changes in hematological system have a longer predictor value for human toxicity when data are translated from animal studies [33]. The treatment with *Terminalia catappa* extract across groups III, IV, V and VI compared to group treated with MSG alone (group II), showed an increase in white blood cell count and could be attributed to the potential of *Terminalia catappa* endocarp extract to stimulate the immune system. White blood cells (WBC) are important in immune response [34] and are commonly released in response to toxic effect in animals. WBCs have been known to play very essential roles in improving the immune system via the formation of first line of defense against invading microorganism [35, 36]. Red blood cells, hemoglobin concentration and packed cell volume (PCV) have been used to detect anemia and its severity and to monitor an anemic patient's response to treatment [35]. There was a significant ($p<0.05$) increase in RBC in the extract alone administered group as compared to the MSG-alone treated group. The MSG-extract co-treated groups (V and VI) showed a significant ($p<0.05$) increase in RBC concentration but non-significant decrease for group IV rats when compared to the MSG-alone treated group (II). Results showed that the MSG may have counteracted the positive ameliorative potentials of the extract in raising the blood concentration. Haemoglobin (Hb) and packed cell volume (PCV) in MSG-extract co-administered rats showed a positive ameliorative effect of the extract in a dose dependent manner when compared to group II. The elevation of these parameters after treatment with *Terminalia catappa* endocarp extract could be linked to the rich iron content of most green leafy plants which makes them readily available sources of iron required in the process of erythropoiesis [37]. Reduction in the concentration of haemoglobin and packed cell volume as observed in group IV probably suggested the presence of a toxic factor (haemaglutinin) which is believed to have an adverse effect on blood formation [38]. Furthermore, the reduction in the percentage of haemoglobin concentration results in poor transportation of oxygen from the respiratory organs to the peripheral tissues, and carbon dioxide protons for subsequent excretion [39].

Throughout the study period, weight of animals in group III (extract group) showed there was a non significant ($p>0.05$) increase compared to those in group II (MSG group). This suggested that the extract might have contained some appetitive stimulating bioactive compounds. However, a decline in weight of animals fed MSG alone (group 2) compared to group I (normal control) may be attributed to a reduction in food intake which was noticed after the second week of administration of MSG to the animals. These results agree with the findings of [40] who reported that animals in MSG-treated group increased in body weight (3.24%) initially but reduced in weight as compared to animals in control group which had a 23.9% weight gain. However, in a study carried out by [41], administration of monosodium glutamate has been associated with increased body weight. Administration of 300mg/kgb.wt extract concomitantly with MSG showed the animals tolerated the extract at that concentration and thus, a sharp increase in percentage gain of body weight.

CONCLUSION

The results showed that the fruit wastes had antioxidant potency and haematological potential. This bio-approach is promising as it solves the problem of environmental burden, as well as, serves economic benefits and hence, may become increasingly attractive.

Conflict of interest statement

The authors report no conflict of interest.

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