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Effects of *Terminalia macroptera* Stem Bark Extracts on the Quantity of Food Intake, Body Weight Change and Some Organometric Parameters in Female *Wistar* Albino Rats

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Abstract: *The effect of Terminalia macroptera (TM) stem bark extracts on food intake (FI), food to body weight conversion index (FBWCI) and organometric changes in liver, kidney and heart was examined. Female wistar albino rats were randomized into 7 groups (n=4) per extract evaluation and administration done orally by gavage in graded doses (50 - 1200 mg/kg b. w.). FI and body weights were determined at intervals of 3 days respectively while organometric analysis was performed on day 28. The results showed that the administered doses produced an immediate loss in appetite and consequent depression in FI when compared to control group. However, 400-600 mg/kg b. w. dosed animals regained appetite and reverted to near normal FI. Despite this observation, only a marginal increase in body weight occurred when compared to control group at the end of the experiment, while marked decrease in body weights were observed in the high dosed groups. However, the organometric changes for the highest dosed groups compared favourably well with those of control. The ability of TM to induce anorexia, reduction in FI and significant decrease (P<0.05) in body weight of normal rats calls for investigation into its possible use for obesity management.*
Keywords: *Terminalia macroptera, food intake, food to body weight conversion index.*

I. Introduction

Terminalia macroptera is a shrub with an open, spread-out crown that possesses deep fissured corky bark that are fire resistant and are found in open woodland with mean annual rainfall of 700 – 1500 mm [1]. The tree has been shown to be useful for a range of medicinal applications [2]. The phytochemical composition of the aqueous and ethanolic stem bark extracts has shown the presence of major bioactive molecules that may be linked to the acclaimed curative properties of the stem bark [3,4]. Particularly, investigations have revealed high concentrations of tannins and saponins among other phytochemicals [4,5].

Plant extracts have been exploited for their ability to alter food intake and body weight through alteration of absorption and food conversion rate while their therapeutic potentials are harnessed to maintain the health status of the animals [6,7]. The evaluation of food intake is important in the safety study of extracts with therapeutic purposes because proper nutritional consumption is crucial to the physiological status of the animals and to obtain a proper response to the tested sample instead of a false response due to nutritionally imposed factors or imbalance. Body weight changes in animals are common indices of adverse effects of drugs because of abnormal metabolic toxic reactions [8].

The aim of this study was to evaluate the effect of *Terminalia macroptera* stem bark extract with respect to feed intake and body weight conversion as well as determine the organometric changes caused to the liver, kidneys and heart.

II. Materials and Methods

2.1 Collection of Plant Material and Preparation of Plant Extracts

Matured stem barks of *Terminalia macroptera* were obtained from open forest in Ilorin, Kwara State and identified as previously reported [4].

The aqueous and ethanolic plant extracts were obtained by conventional solvent extraction method in a sample to water ratio of 1/4, for 72 hours and at temperature 8-15 ^oC and 25 ^oC respectively. The concentrated solutions was then freeze dried and stored at 4 ^oC [4].

2.2 Study Area and Conditions

The rats were maintained in well ventilated cages under standard laboratory conditions of temperature 20 °C - 26 °C, photo sequence of 12 hours light and 12 hours dark, and relative humidity of 60 (± 5) % at the animal house of the Department of Biochemistry, University of Benin. They were allowed access to standard pelleted mash and water *ad libitum*. The rats were allowed to acclimatize for one week prior to commencement of experiment.

2.3 Animal and Experiment Protocol

The animals were randomized into 6 groups per extract experiment containing 4 animals each. The crude extract was administered orally by gastric gavage, 3 hours preprandially according to the gradations (50, 200, 400, 600, 1000 and 1200 mg/kg body weight), while a 7th group being the control with an equal number of animals received distilled water in an equivalent volume of the maximum test dose at the same time and under the same condition.

2.4 Evaluation of Food Intake

Administered food were pre – weighed in the morning and at the end of 24 hours every 3 days. Food intake per rat was calculated thus:

FI (g) / 100g body weight = GF – (LO + WF)/4 ……………………………………………………………………..(1)

Where GF = Given amount of feed in grammes; LO = left over feed in grammes; WF = Wasted feed in grammes; FI = Feed intake in grammes per cage of 4 rats; FI = Feed intake.

2.5 Body Weight Measurement

The body weights were monitored throughout the experimental period every three days and percentage body weight change calculated thus:

% body weight change = 100 (BW_t – BW_i) / BW_i …………………………………………………………………….(2)

BW_t = Body weight at different time point and BW_i = initial body weight at start of experiment

2.6 Organ Collection

The livers, kidneys and hearts of the rats were extracted, rinsed in physiological saline (0.9 %) and weighed after being dried between layers of whatman filter paper.

2.7 Statistical Analysis

Differences in the means of variables were calculated using a one–way analysis of variance followed by Duncan’s multiple range test. Relationships between food intake and body weights at different doses were determined by scattered plots and regression coefficient calculated respectively.

III. Results

Fig. 1 shows the food intake of female *wistar* albino rats fed with aqueous extract of *T. macroptera* stem bark for four weeks. The control group showed a brief increase in food intake from day 1 (14.44 g/100g body weight) to day 4 (15.86 g/100g body weight), which was not sustained. The food intake curve for the control group showed a pulsated decrease till the last week of the experiment where it remained fairly constant with the animals consuming between 8.71 – 9.72 g/100g body weight. All administered doses (50, 200, 400, 600, 1000 and 1200 mg/kg b. w.) of aqueous extract caused immediate depression in food intake from day 1 to day 4, after which rates were consistent till day 19. Although none of the groups is able to revert feed rate to initial level, the groups administered 200, 400, and 600 mg/kg b. w. respectively were however, able to show gradual elevation to near control level at the last week of the experiment while the group of animals dosed with 1000 mg/kg and 1200 mg/kg b. w. of aqueous extract showed a decrease in rate of food intake that remained fairly constant for the 4 weeks of the experiment when compared to control rats.

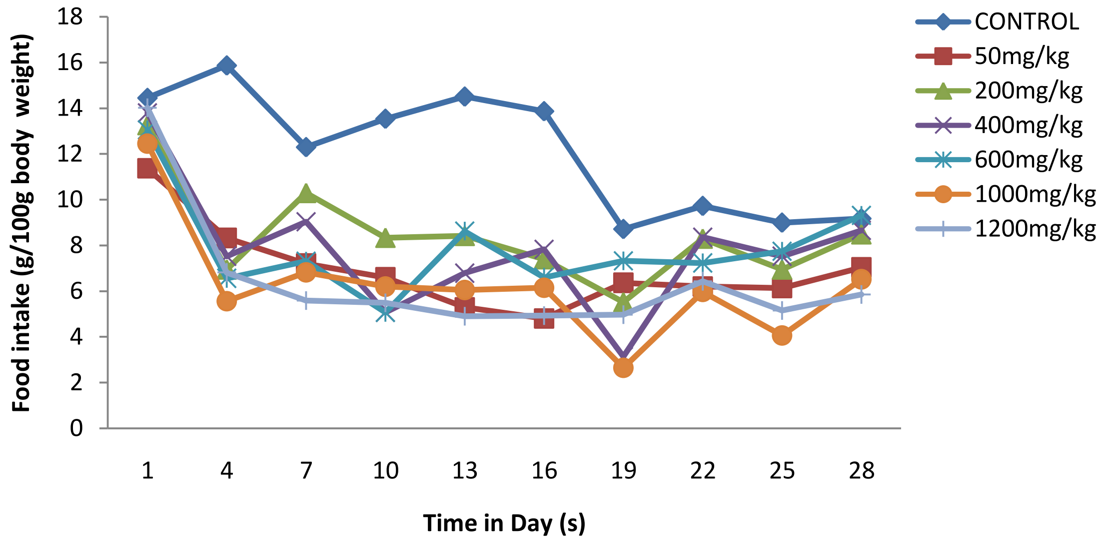

Figure 1**:** Food intake of female *wistar* albino rats administered aqueous extract of *T. macroptera* stem bark for four weeks. Data are plotted as mean food intake of 4 rats per group at three days interval.

Fig. 2 below shows the mean food intake of female *wistar* albino rats fed with ethanolic extract of *T. macroptera* stem bark for four weeks. All doses caused immediate depression in food intake when compared with control for the first two weeks of the experiment. The group of animals dosed with 50 mg/kg b. w. of ethanolic extract showed a gradual but continous decrease in the rate of food intake till day 16, after which it peaked on days 19 and 22 before troughing on day 25. Animals dosed with 400 mg/kg and 600 mg/kg b. w. of ethanolic extract respectively showed gradual elevation in food intake above control group in the last week. However, only the animals administered 400 mg/kg b. w. extract dose were able to show effective recovery from initial depressed state.

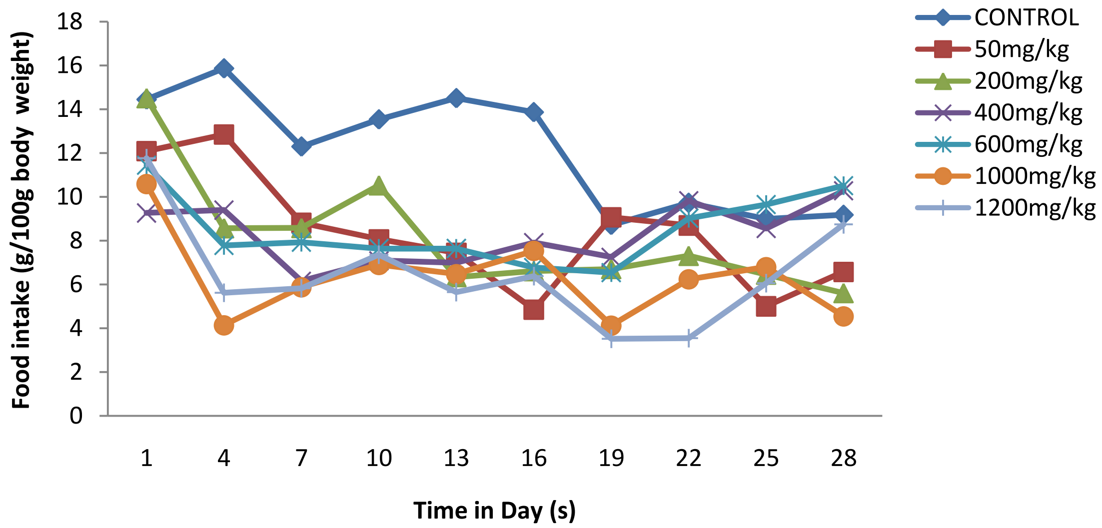

Figure 2: Food intake of female *wistar* albino rats administered ethanolic extract of *T. macroptera* stem bark for four weeks. Data are plotted as mean food intake of 4 rats per group at three days interval.

Fig. 3 below shows the percentage body weight change of rats administered aqueous extract for 28 days. An inverse dose dependent change in percentage body weight was observed on day 7 of administration with aqueous extract of *Terminalia macroptera*: 50mg/kg b. w.(10.21 ± 2.01 %), 200 mg/kg b. w. (3.93 ± 2.37 %), 400 mg/kg b. w. (3.74 ± 2.06 %), 600 mg/kg b. w. (0.73 ± 2.28 %), and 1000 mg/kg b. w. (-0.75 ± 2.20 %). All the groups administered aqueous extract reflected non-significant reduction in percentage body weight gained when compared with control group on the 28th day of experiment except the group dosed with 1000 mg/kg and 1200 mg/kg which showed significant body weight loss (1.85 - 4.78 %). The control rats maintained their basal weight value.

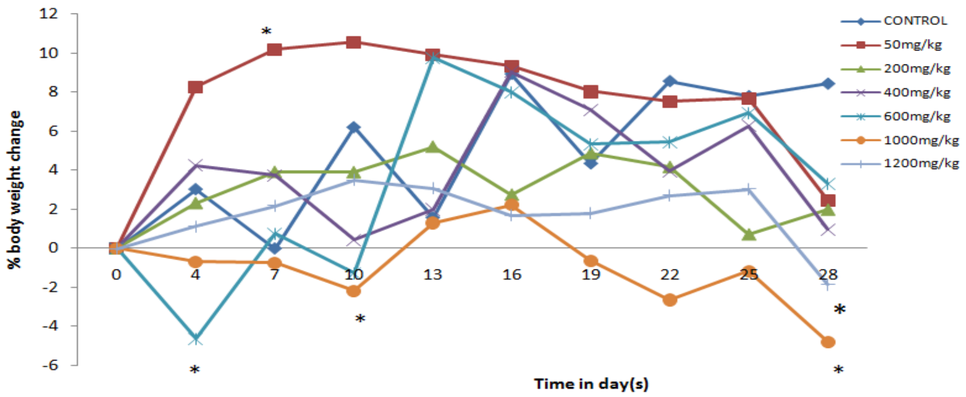

Figure 3: Percentage body weight change of rats administered aqueous extract for 28 days. Data are plotted as mean percentage change in body weight from base line values. Differences between test and control values were set at significance $P < 0.05$ indicated by (*).

Fig. 4 below shows the percentage body weight change of rats administered ethanolic extract for 28 days. An inverse dose dependent change in percentage body weight was observed on day 7 of administration of ethanolic extract. The doses of 50 mg/kg, 200 mg/kg, 400 mg/kg, 600 mg/kg, 1000 mg/kg and 1200 mg/kg showed 5.27 ± 1.15 %, 3.83 ± 2.35 %, 2.81 ± 1.36 %, 1.26 ± 1.66 %, -2.97 ± 0.99 % and -9.25 ± 1.22 % body weight change respectively. The control animals showed the expected weight gain for the first 16 days of the experiment, after which a fairly constant weight was maintained till the last week of experiment. In a development similar to that in animals dosed with aqueous extract, all the groups of *wistar* rats administered ethanolic extract of *Terminalia macroptera* stem bark reflected non-significant reduction in percentage body weight gained on the 28th day when compared with control group except for those administered 1000 mg/kg b. w. (-15.90 ± 5.06 %) and 1200 mg/kg b. w. (-9.03 ± 1.94 %) whose body weight were significantly reduced.

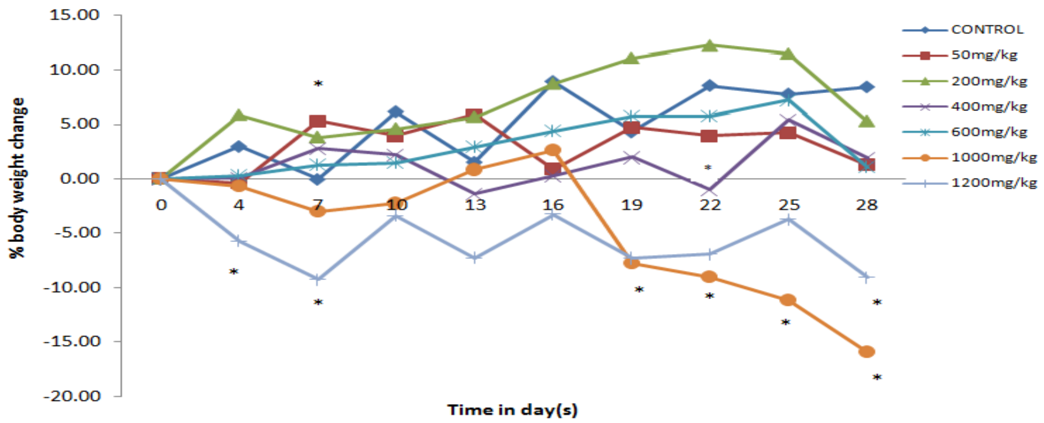

Figure 4: Percentage body weight change of rats administered ethanolic extract for 28 days. Data are plotted as mean percentage change in body weight from base line values. Differences between test and control values are set at significance $P < 0.05$ indicated by (*).

The correlation between food intake and body weight is shown below in Table 1. The table showed that the mean food intake in the groups dosed with 50-1200 mg/kg body weight were negatively correlated with mean body weight of rats, except the groups dosed with 1000 mg/kg (aqueous extract) and 1000 - 1200 mg/kg (ethanolic extract). The negative correlations shown in the lower doses reflected an inverse relationship between food intake and the weight of the animals. However, this correlation got weaker as the doses approached 600 mg/kg body weight. The administered doses at 600 mg/kg totally showed no correlation between food intake and body weight change. Interestingly, this observation was consistent for both extracts. The correlations of the doses above 600 mg/kg showed a clear deviation from those of the lower doses except for the group administered 1200 mg/kg aqueous extract. From computation, 83.33 % and 66.67 % of the experimental groups (aqueous and ethanolic respectively) did not show positive significant correlation between food intake and body weight. Although, control animals showed a similar negative slope, the food intake became fairly stabilized after day 19 (fig. 1 and 2).

Table 1: Correlation between food intake and body weight

Dose (mg/kg b. w.)	Slope	Intercept@ y-axis	Regression Coefficient	% Correlation
Control	-1.245	186.1	0.323	56.83
50 (Aqueous)	-2.767	247.9	0.480	69.28
50 (Ethanolic)	-0.683	202.4	0.190	43.59
200 (Aqueous)	-0.879	188.5	0.344	58.65
200 (Ethanolic)	-1.787	191.7	0.527	72.59
400 (Aqueous)	-0.623	179.7	0.101	31.78
400 (Ethanolic)	-0.906	230.3	0.065	25.50
600 (Aqueous)	-0.119	179.5	0.000	0.00
600 (Ethanolic)	-0.054	194.8	0.000	0.00
1000 (Aqueous)	0.149	213.6	0.008	8.94
1000 (Ethanolic)	3.014	190.2	0.191	43.70
1200 (Aqueous)	-0.333	186.5	0.094	30.66
1200 (Ethanolic)	1.416	191.4	0.303	55.05

A positive slope indicated that the change in body weight is directly proportional to the change in food intake while a negative slope indicated that the change in body weight is inversely related to the change in food intake. The regression coefficient reflected the extent to which the change in body weight was accounted for by the change in food intake.

Fig. 5 below shows the liver-to-body weight ratio of rats after 28 days of oral administration of aqueous and ethanolic extract of *T. macroptera* stem bark. All doses of aqueous extract except 1200mg/kg b. w. caused significant reduction (*P < 0.05*) in the liver to body weight ratios.

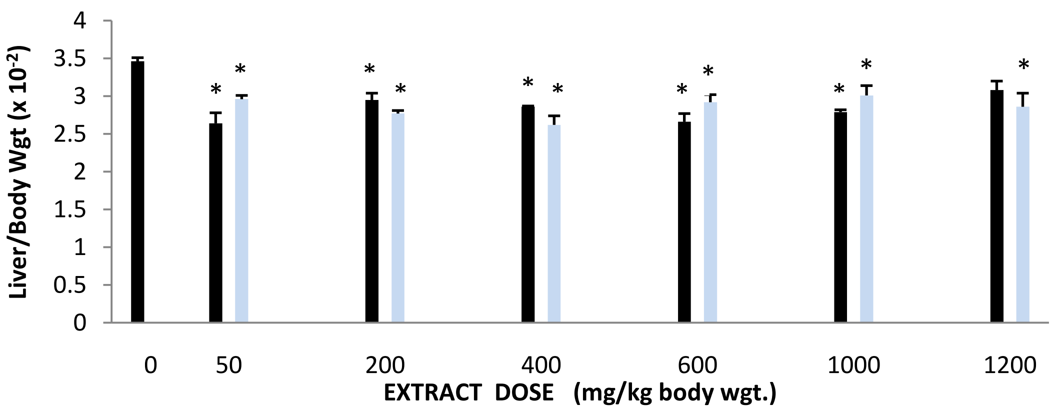

Figure 5: Liver-to-body weight ratio of rats after 28 days of oral administration of aqueous and ethanolic extract of *T. macroptera* stem bark. Differences between test and control values are set at significance *P < 0.05* indicated by (*) for *n=4*. The black coloured bar charts represent hepatometric ratios of rats administration aqueous extract, while the blue coloured bar charts present hepatometric ratios of rats administration ethanolic extract.

Fig. 6 below shows the kidney-to-body weight ratio of rats after 28 days of oral administration of aqueous and ethanolic extract of *T. macroptera* stem bark. Extracts at all administered doses caused no significant changes in the organ to body weight ratios of right and left kidney, though the ratio were all numerically reduced when compared with control animals.

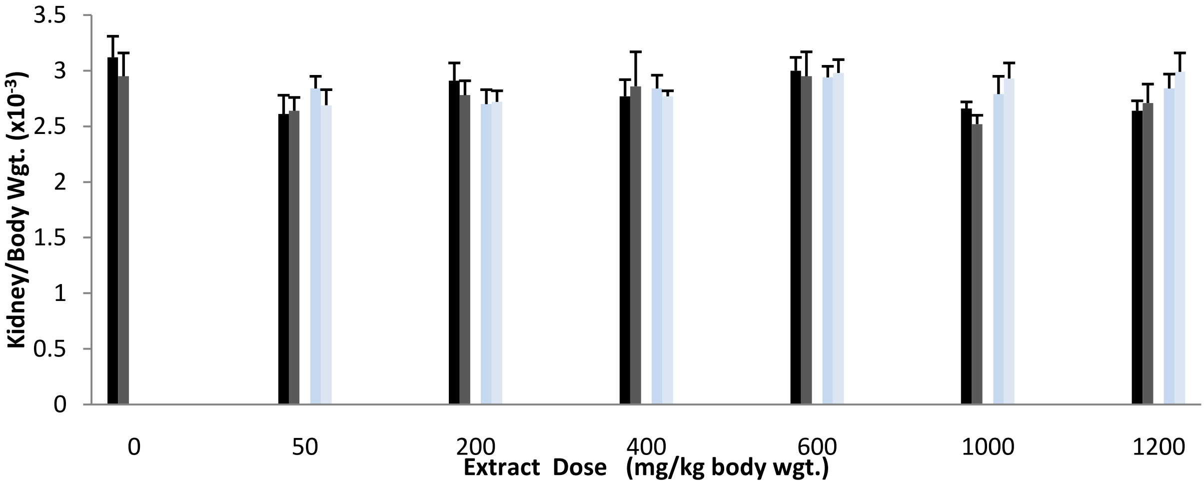

Figure 6: Kidney-to-body weight ratio of rats after 28 days of oral administration of aqueous and ethanolic extract of *T. macroptera* stem bark. Differences between test and control values are set at significance $P < 0.05$ indicated by (*) for $n = 4$. The pair of black and dark ash histograms represents nephrometric ratios (right and left kidneys) of rats administered aqueous extract, while the pair of blue and light blue histograms represents nephrometric ratios (right and left kidneys) of rats administered ethanolic extract.

Fig. 7 below shows the heart-to-body weight ratio of rats after 28 days of oral administration of aqueous and ethanolic extract of *T. macroptera* stem bark. There were significant increase in the heart-to body weight ratios at 400 mg/kg and 600 mg/kg aqueous extract while doses of ethanolic extract caused non-significant increase in heart to body weight ratio when compared to control group except 400 mg/kg which induced a non-significant reduction.

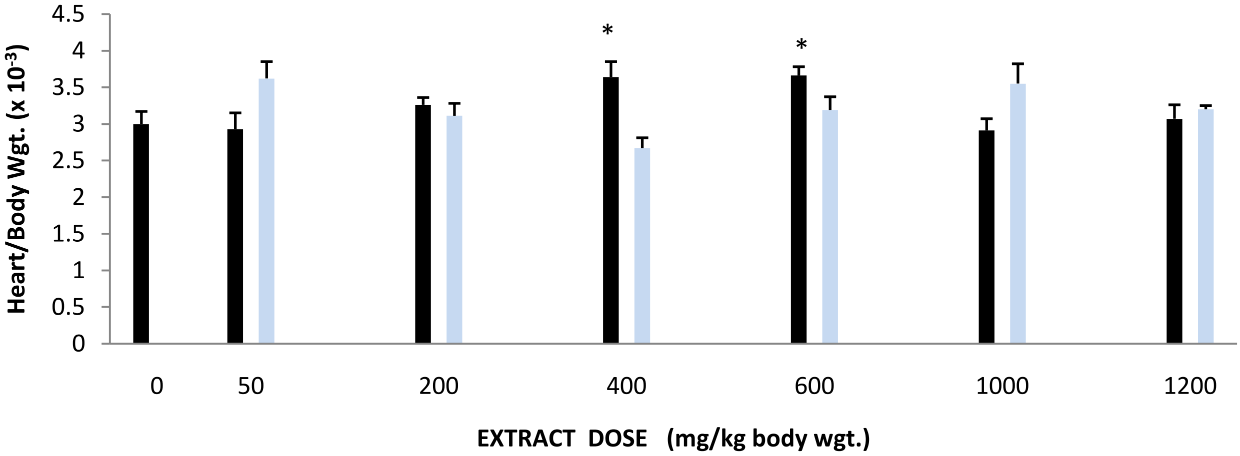

Figure 7: Heart-to-body weight ratio of rats after 28 days of oral administration of aqueous and ethanolic extract of *T. macroptera* stem bark. Differences between test and control values are set at significance $P < 0.05$ indicated by (*) for $n=4$. The black coloured bar charts represent cardiometric ratios of rats administration aqueous extract, while the blue coloured bar charts present cardiometric ratios of rats administration ethanolic extract.

IV. Discussion

The effect of *T. macroptera* foliage on feeding has been studied [7], but work has not been done on its stem bark extract with respect to feeding before now despite the numerous researches that have been conducted to examined its medicinal potential.

In this study, the feeding rate of female *wistar* albino rats were observed to be depressed upon administration of extracts of the stem bark. Although, control animals equally showed gradual decrease in food intake. This may be due to a number of factors that were not very clear during the study, such as the stress in handling the animals or the effect of circulating oestrogen [9]. However, increase in body weight was recorded at the end of the experiment. These data are consistent with the findings of Fleming [10] and Gerardo-Gettens *et al*. [11], however, they contrasted with the normal trend that increased food intake is associated with corresponding increase in body weight of normal animals [12].

The immediate depression in food intake noticed in the variously dosed animals (when compared to control group) for the first 2 weeks of experiment may be due to the presence of phytochemicals like tannins which have been screened to be in abundance in the stem bark [4]. Previous investigations on plant extracts have shown that tannins have the capacity to cause reduction in appetite [7,13,14]. The lower doses of the extracts were able to restore food intake to near normal level (of which 400-600 mg/kg b. w. aqueous extract were the most effective), but these changes only translated to small increase in body weight that were quite below those of control group on 28th day. The extracts at these concentrations may be a useful panacea in the management of obesity. Specifically, the depression in food intake caused by the higher doses of the extracts remained fairly constant at that level till the end of the experiment. This may account for the significant decrease observed in the body weight of the high dosed animals when compared to control group. This outcome is not different from the findings of Asagba and his co-researchers that reported that aqueous extract of *Hibiscus sabdariffa* L. caused weight lost instead of gain when administered alone to male albino rats (*wistar* strain) [15]. It will be proper to state however, that the factors that mediated the decrease in body weight when administered the extract remained to be established.

The observation recorded in table 1 showed that the food intake was not entirely responsible for the changes in body weight, drawing conclusion from the fact that experimental groups did not show positive correlation between food intake and body weight, except for the high dosed groups. It was obvious from the results that though the lower doses of extract caused a reduced food intake, the probable mechanism behind the food absorption and utilization seem not to be hampered, since the little quantity of food consumed appeared to have been utilized in weight gain, whereas the reduction in food intake caused by the higher doses definitely imparted on the weight of the animals. This is true from the positive slopes noticed in groups administered 1000 - 1200 mg/kg, a positivity that is due to corresponding decrease in values of food intakes and body weights of the test animals. Interestingly, 50 mg/kg (aqueous extract) and 200 mg/kg (ethanolic extract) showed a stronger potential to convert food intake to body mass, where a decrease in food intake by 1 g/100g body weight did not cause a decrease in body weight gained but instead an increase of 2.77 g and 1.79 g were noticed respectively. This most likely may be tied to the increased absorption of glucose from the blood stream and probably its utilization in glycogenesis. However, this ascertion remains to be proven.

Organometrics have reportedly been used as one of the indices of toxicology [15,16] and consequently in this present study, the ratios of the liver, kidney and heart weights to the respective body weights were evaluated. The significant to non–significant reduction in the liver to body weight ratio observed in the dosed animals may indicate an absence of inflammation and a consequent healthy hepatic state, however further biochemical verification would be needed to concretize the claim. It is of interest to note also that the significant reduction in the hepatometric ratios were consistent with the weight reduction reflected in the body of the animals when compared to control group. It could be postulated that an overall decrease in the body weight of the animals induced by the extracts, concomitantly reduced the weight of liver in the body. Omonkhua and Onoagbe [14] have reasoned that the decrease in weight of an organ may be due to series of reactions taking place within the organism in response to an imposed factor. The result of this study, is however, in contrast with a previous organometric investigation carried out on male albino rats administered aqueous stem bark extract of *Khaya senegalensis,* where hepatomegaly was reported [17]. In a further confirmation of the non-inflammatory property of the extract, no significant changes were observed in nephrometric and cardiometric ratios of administered groups when compared to control even at the highest doses. The significant increase in the heart-to-body weight ratios in 400-600 mg/kg aqueous extract dosed groups may however, be due to intrinsic factors that are obscure presently.

V. Conclusion

In this study, *Terminalia macroptera* stem bark extracts were able to cause depression in food intake and body weight. The result of this study indicated that the stem bark extracts alters the food conversion rate of animals at least in part without gross stimulation of toxic response. However, further biochemical proof would be required to conclude on the submission.

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