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Effects of Canned Tomatoes Consumption on Hematological Profile, Renal Markers, and Histology Using Male Wistar Rats

Ezon-Ebidor Innocent Edibamode [a*] and Kanayo Mercy Odia [b]

[a] Department of Human Anatomy, Faculty of Basic Medical Sciences, University of Port Harcourt, Nigeria.
[b] Department of Human Physiology, Faculty of Basic Medical Sciences, University of Port Harcourt, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Background: Tomatoes are currently an important food component globally, they are the largest vegetable both in terms of production and consumption. This study was aimed at investigating the effect of tomato consumption on hematological parameters, renal markers, and renal histology of male Wistar rats.
Methods: A study involved 20 male Wistar rats and 30 pieces of Gino tomato paste. The rats were acclimatized for 14 days and divided into two groups. The experiment was carried out in two phases, with the experimental group fed tomato paste and water. After each phase, samples were collected for hematological and biochemical analysis.

**Corresponding author: E-mail: edibamode.innocent@gmail.com;*

Results: The results from the hematological analysis show that Packed Cell Volume, Hemoglobin, and Red Blood Cells were significant in the acute phase while they were not in the recuperation phase. The Biochemical analysis shows Potassium and Chloride (Cl^-) as not significant although potassium levels were found to be very high in the acute phase while none of the biochemical parameters were found to be significant in the recuperation phase. Histologically there were no observed pathological changes of the normal kidney against the kidney of tomato administer rats.
Conclusion: The study shows that consumption of tomato paste affects renal maker Potassium as it increases its normal level. It further shows that consuming tomato paste increases the Hemoglobin, Pack Cell Volume, and Red Blood Cells.

Keywords: Tomatoes; consumption; hematological parameters; renal makers; male Wistar rat.

1. INTRODUCTION

Tomato is a fleshy berry that is widely grown as a perishable fruit and vegetable in tropical and temperate climates around the world [1]. It is normally more than 90% water, and once harvested, it begins to respire at faster rates, leading to moisture loss, quality deterioration, and possibly microbial spoiling [2]. Harvesting separates the fruit or vegetable from its source of nutrients. In many circumstances, fresh tomatoes have a shelf life of only days before they become dangerous or unsuitable for ingestion [3]. As a result, storage, food preservation, and processing methods have been used for ages to transform perishable fruits and vegetables, including tomatoes, into safe, tasty, and stable goods [4].

Food preservation entails treating and processing food to prevent deterioration and increase storage time [5]. Traditional procedures include drying, cooling, and fermentation, whereas current methods include canning, pasteurization, freezing, and chemical addition [6]. Canning is a method of preserving food that involves processing the ingredients and sealing them in an airtight container [7]. Thus, under certain conditions, freeze-dried canned items can last up to 30 years in an edible state. Canned tomatoes frequently contain preservatives such as salt, which not only preserves but also provides flavor; citric acid and calcium chloride can also be present in canned tomatoes [7,8]. Both are considered safe to consume. Citric acid preserves color, and calcium chloride keeps tomato paste stiff.

According to one study, canned fruits and vegetables have as much nutritional fiber and vitamins as their fresh or frozen counterparts, and in some cases more [9]. Canned food is frequently sterilized by steam heating to a temperature high enough to kill bacteria. On the plus side, heat kills microbial pathogens, spoilage organisms, and endogenous or imported enzymes that would otherwise leave the food inedible or unhealthy. The heat of the sterilization process also causes a significant loss of concentrations in nutrients, particularly heat-labile vitamins including thiamine, vitamin B1, vitamin C, and folate [10]. But Canning has no significant impact on the carbohydrate, protein, or fat content of meals. Vitamins A, D, and beta-carotene are heat-resistant [11]. Although canned foods include anaerobic conditions, which may serve as a protective effect on the stability of vitamin C, this effect can be removed by extended heat treatments [12].

It is also worth noting that removing the peels and seeds, two common techniques used during the preparation of canned tomatoes, can affect the physicochemical properties, bioactive compound content, and antioxidant potential of tomato fruits [13]. Peeling the skin of tomatoes before processing reduces their lycopene, β-carotene, ascorbic acid, and phenolics content, as well as their antioxidant activity [14]. Seed removal, on the other hand, favored an increase in both color and sweetness, but some bioactive chemicals (11% of carotenoids and 24% of phenolics) and antioxidant activity (5%) were lost [15,16].

Tomatoes contain lycopene, a phytochemical or natural plant ingredient that promotes health [17]. Lycopene, an antioxidant, has been demonstrated in multiple trials to benefit breast cancer, heart cancer, inflammation, prostate cancer, premature aging, cardiovascular disease, osteoporosis, diabetes, and a variety of other disorders [18]. Canned tomatoes contain considerably more lycopene bioavailable than fresh tomatoes, so you get more. When tomatoes are cooked, as they are in all processed tomatoes (such as cans, jars, sauces, salsa, and ketchup) [19], the lycopene becomes more available to the body. This is because heating opens up the tomato plant's cell walls,

allowing lycopene to be taken into the body. Consumption of certain canned foods has been linked to health risks, as canned goods are typically regarded to be less nutritious than fresh foods due to the presence of trace amounts of Bisphenol A (BPA) [20]. Canned tomatoes are one of the most widely consumed products. The kidney is one of the key organs that is affected by toxic consumables, thus this study was designed with that in mind [21]. The purpose was to investigate the influence of tomato consumption on the hematological parameters, renal indicators, and renal histology of male Wistar rats.

2. MATERIALS AND METHODS

2.1 Procurement of Canned Tomatoes

Gino tomatoes were purchased from Everyday Shopping Mall Choba. 30 pieces of the tomatoes (Gino) were used to feed the rats for 3 weeks.

2.2 Animal Procurement/ Acclimatization

Twenty (20) male Wistar rats weighing (80-130g) were procured from the animal house of the Faculty of Basic Medical Sciences, University of Port Harcourt, and acclimatized for a two (2) week period where they were fed with standard fed and water *ad libitum*. These animals were then randomly divided into two (2) groups of ten (10) animals each (Experimental and Control).

The rats were acclimated for 14 days in properly disinfected wooden cages with wire gauze doors for aeration and lighting to enable them to get used to one another and also to their new environment. During this period of adaptation, the rats were maintained on a standard basal diet of Top feed with water twice daily.

2.3 Research Design

This research lasted for about three (3) months and was carried out in two (2) phases after the expiration of the two (2) weeks acclimatization period.

Phase 1

This was an acute phase study that lasted for three weeks (21 days). During this period the experimental group only was given 63.5g of Gino tomato paste and water *ad libitum*, while the control group was fed with only Top fed and water *ad libitum* throughout the twenty-one (21) days.

Phase 2

This is a recuperation phase study which also lasted for three weeks (21 days). During this period, animals in both experimental and control groups were fed with 100g Top feed and water *ad libitum* Twice daily.

2.4 Sample Collection

At the end of both phases, blood samples were collected randomly from five (5) animals each from both groups and both phases respectively, for hematological, biochemical, and histological analysis (Tissue processing). The animals were anesthetized with chloroform. Each rat was placed on the table and the thoracic cavity was dissected to expose the heart, and other vital organs, 2ml of blood was collected from each rat via cardiac puncture and were placed into an anticoagulant bottle (EDTA bottle). Blood samples were taken to Divic Medical and Analytical Laboratory Rumuosi, Port Harcourt for hematological and biochemical analysis. While the kidneys were harvested, placed in plain bottles, and fixed with 10% formal saline as a preservative, they were sent to the Histology laboratory University of Port Harcourt for tissue processing.

2.5 Proximate Analysis and Antioxidant

2.5.1 Determination of moisture content

Moisture content was determined according to the standard methods of the Association of Official Analytical Chemists (AOAC) [21]. Stainless steel oven dishes were cleaned and dried in the oven at 100ºC for 1 hour to achieve a constant weight. They were cooled in a desiccator and then weighed. Two grams of sample was placed in each dish and dried in the oven at 100ºC until constant weight was achieved. The dishes together with the samples were cooled in a desiccator and weighed.

$$Ash = \frac{(W_1 - W_2)}{(W_1 - W_2)} \times \frac{100}{1}$$

Where;

W_1 = weight of dish
W_2 = weight of dish + sample before drying
W3 = weight of dish + sample after drying

2.5.2 Determination of crude protein

Crude protein was determined using the Kjeldahl method (AOAC, 2010). Two grams of sample were placed in the Kjeldahl flask. Anhydrous sodium sulfate (5g of Kjeldahl catalyst) was added to the flask. Concentrated H2SO4 (25ml) was added with a few boiling chips. The flask was heated in the fume chamber until the sample solution became clear. The sample solution was allowed to cool to room temperature, then transferred into a 250ml volumetric flask and made up to volume with distilled water. The distillation unit was cleaned, and the apparatus was set up. Five milliliters of 2% boric acid solution with a few drops of methyl red indicator was introduced into a distillate collector (100ml conical flask). The conical flask was placed under the condenser. Then 5ml of the sample digest was pipetted into the apparatus and washed down with distilled water. Five milliliters of 60% sodium hydroxide solution was added to the digest. The sample was heated until 100ml of distillate was collected in the receiving flask. The content of the receiving flask was titrated with 0.049M H2SO4 to a pink-colored end point. A blank with filter paper was subjected to the same procedure.
Calculation:

$$\%\ Total\ Nitrogen = \frac{(ntirte - Blanks) \times Normality\ of\ acid \times N_2}{Weight\ of\ sample}$$

Nitrogen factor = 6.25
Crude protein = % total N x 6.25

2.5.3 Determination of fat

The fat content was determined according to AOAC's (2010) soxhlet extraction method. A 500ml round bottom flask was filled with 300ml petroleum ether and fixed to the soxhlet extractor. Two grams of sample were placed in a labeled thimble. The extractor thimble was sealed with cotton wool. Heat was applied to reflux the apparatus for six hours. The thimble was removed with care. The petroleum ether was recovered for reuse. When the flask was free of ether it was removed and dried at 105ºC for 1 hour in an oven. The flask was cooled in a desiccator and weighed.

Calculation:

$$\%\ fat = \frac{Weight\ of\ fat}{Weight\ of\ sample} \times \frac{100}{1}$$

2.5.4 Determination of crude fibre

Crude fiber was determined using the method in AOAC (2010). Three (3) grams of the sample were weighed into a 50ml beaker and fat was extracted with petroleum ether by stirring, settling, and decanting three times. The extracted sample was air-dried and transferred to a 600ml dried beaker. Then 200ml of 1.25% sulphuric acid and a few drops of anti-foaming agent were added to the beaker. The beaker was placed on a digestion apparatus with pre-adjusted hot plate and boiled for 30 minutes, rotating the beaker periodically to keep the solid from adhering to the sides of the beaker. At the end of the 30 minutes, the mixture was allowed to stand for one minute and then filtered through a Buchner funnel. Without breaking suction, the insoluble matter was washed with boiling water until it was free of the acid. The residue was washed back into the original flask using a wash bottle containing 200ml of 1.25% sodium hydroxide solution. It was again boiled briskly for 30 minutes with similar precautions as before. After boiling for 30 minutes, it was allowed to stand for one minute and filtered immediately under suction. The residue was washed with boiling water, followed by 1% hydrochloric acid, and finally with boiling water until it was free of acid. It was washed twice with alcohol and then with ether three times. The residue was transferred into an ash dish and dried at 1000C to a constant weight. Incineration to ash was done at 6000C for 30 minutes, cooled in a desiccator, and weighed. The difference in weight between oven-dry weight and the weight after incineration was taken as the fiber content of the sample. This was expressed as a percentage weight of the original sample taken for analysis.

$$\%\ Crude\ fibre = \frac{Oven\ dried\ sample - weight\ of\ sample\ incineration}{Weight\ of\ sample} \times \frac{100}{1}$$

2.5.5 Determination of carbohydrates

The Carbohydrate was determined by difference according to Oyenuga (1968), as follows:

% Carbohydrates =

100 (% moisture + % fat + % ash + % protein + % crude fibre)

2.5.6 Determination of ash content

Ash determination was carried out according to AOAC's (2010) procedure. Two grams of sample were placed in a silica dish which had been ignited, cooled, and weighed. The dish and sample were ignited first gently and then at 550ºC in a muffle furnace for 3 hours until a white or grey ash was obtained. The dish and contents were cooled in a desiccator and weighed.

$$\%\ Ash = \frac{(W_1 - W_2)}{(W_1 - W_2)} \times \frac{100}{1}$$

Where

W1 = weight of dish
W2 = weight of dish + sample before ashing
W3 = weight of dish + sample after ashing

2.5.7 Spectrophotometric determination of lycopene

Starting with a well-homogenized juice sample (prepared under vacuum to minimize the introduction of air bubbles), a 100-microliter micropipette was used to take samples, and samples were dispensed into a screw cap tube. Several blank samples were prepared with 100 microliter of water instead of juice samples. 8.0ml of hexane: ethanol: acetone (2:1:1) were added using a pipetter. The tube was capped and vortexed immediately and incubated out of bright light. After at least 10 minutes, or as long as several hours later, 1.0ml of water was added to each tube and vortexed again. Samples were allowed to stand for 10 minutes to allow phases to separate and all air bubbles to disappear. The cuvette was rinsed with the upper from one of the blank samples. It was then discarded, and a fresh blank was used to zero the spectrophotometer at 503nm. The absorbance was determined at 503nm (A_{503}) of the upper layers of the lycopene samples.

Calculation of lycopene levels

Lycopene (mg/kg fresh wt) =

(A_{503} * 537 * 8 * 0.55)/ (0.10 * 172)

= A_{503} * 137.4

Where,

537g/mole is the molecular weight of lycopene
8ml is the volume of mixed solvent
0.55 is the volume ratio of the upper layer to the mixed solvents
0.10g is the weight of the juice sample added
172 Mm^{-1} is the extinction coefficient for lycopene in hexane
Note: if 100 microliter of juice sample is analyzed but the volume of mixed solvent used is something other than 8ml, then the lycopene concentration can be calculated by:

Lycopene (mg/kg fresh wt) = A_{503} * 17.17 * V
Where V = the volume of mixed solvent added in ml

2.6 Hematology

2.6.1 Hemoglobin (HB)

The hemoglobin concentration in the blood was determined by the Cyanmethemoglobin method. The blood sample (0.2 ml) was mixed with 4 ml of Drebins solution in a test tube and allowed to stand for 15 minutes at room temperature. The absorbance of the mixture was read at 540nm against a reagent blank using a spectrophotometer. The HB was obtained by multiplying the absorbance of the sample with a calibration factor (36.8) derived from the absorbance and concentration of the standard [22].

2.6.2 Packed cell volume (PCV)

The PCV was determined by the microhematocrit method. This was done using the standard technique as described by Coles in 1986 [23]. Blood samples were collected into heparinized capillary tubes. One end of the tubes was sealed with plasticine and centrifuged for 5 minutes at 2500 r.p.m, using a hematocrit centrifuge. The levels of the packed red blood cells in the capillary tubes were read using a PCV hematocrit reader.

2.6.3 White blood cell (WBC)

The white blood cell count was determined by the Hemocytometer method. The blood sample was diluted (1:20) using Turk's solution (2% glacial acetic acid). The diluted sample was loaded into a Neubauer counting chamber with a Pasteur pipette. The WBC was determined by counting the required number in the appropriate squares on the counting chamber under a microscope. The number of cells counted for each blood sample was multiplied by 50 to obtain the total white blood cell count per microlitre of blood described by [24].

2.6.4 Red blood cell (RBC)

This was also determined using the Hematocrit method. A blood sample (0.02ml) was collected with a pipette and added to 4 ml of red blood cell diluting fluid in a clean test.

2.6.5 Platelets count

A blood sample (0.02ml) was collected with a pipette and added to 3.98ml of diluting fluid. An improved Neubauer counting chamber was charged with the well-mixed diluted blood. Platelets were allowed to settle in a moist chamber for 3-5 minutes. The ruled area of the counting chamber was located, under the 40x objective lens the total number of platelets was counted in the four large corner squares.

2.6.6 Complete blood count (CBC)

This is the most common blood test used to determine the levels of different blood cell types, including neutrophils, lymphocytes, basophils, monocytes, and eosinophils

2.7 Biochemical Analysis

2.7.1 Sodium

The test tube was labeled: blank, standard, control, and sample. 1.0ml of Acid reagent was pipetted to all tubes. 50 microfarad of supernatant was added to test tubes and mixed. 50 microfarad of color reagent was added to all tubes and mixed. Zero spectrophotometer with distilled water at 550nm. The absorbance of all test tubes was read using a spectrophotometer.

2.7.2 Potassium

Test tubes were labeled: standard, control, sample, blank, etc. 1.0ml of potassium reagent was pipetted into all tubes. 0.01ml of the sample was added to the respect tubes, mixed, and let to sit at room temperature for 3 minutes. After the said time the wavelength of the spectrophotometer was set to 500nm and zeroed with reagent blank. The absorbance of the tube was read and recorded.

2.7.3 Chloride

The test tube was labeled: blank, calibrator, and specimen. 1.5 ml of chloride reagent was pipetted into each tube. 0.01ml of calibrator was added to each tube and mixed and incubated for at least 5 minutes. The spectrophotometer was set at 480nm and zeroed with a reagent blank. A wavelength of 480-520nm was used. Absorbance was recorded.

2.7.4 Urea

The test tube was labeled: blank, standard, and sample. 0.001ml of urea reagent was pipetted into each tube. 0.1ml of distilled water was added mixed and incubated for 10mins. Absorbance was recorded.

2.8 Histology

Standard methods were used to embed 10% phosphate-buffered formalin-fixed heart tissue in paraffin blocks, it was segmented into 4–5 lm sections, deparaffinized, and then rehydrated. After that, the slices were H&E-stained for cytoarchitectural alterations. The various slides were carefully studied under the microscope and photomicrographs at a magnification of 400 were obtained.

2.9 Statistical Analysis

Statistical analysis was done using the International Business Machine of Statistical Package for Social Scientists (SPSS) to compare the data from the measurements of the animal weight per week, the hematological parameters, and the kidney function test. Results were expressed as mean and standard error of mean evaluated using analysis of variance and student t-test and the level of significance determined $p<0.05$

3. RESULTS AND DISCUSSION

Fig. 1, shows the weight changes of the animals among the control and experimental groups for the first 21 days. In weeks 1 and 3, (t=-0.59, p=0.56 and t=-0.58, p=0.57 respectively) there were no significant changes between the control and the experiment group in the weight changes while in week 2 there were significant changes (t=-2.49, p=0.02). in the last 21 days, weights (g) in weeks 4, 5, and 6 (t=0.99, p=0.35; t=-1.50, p=0.17; t=-1.24, p=0.25) show no significant changes between the control and the experimental.

The proximate and Antioxidant analysis of Gino Tomatoes paste has the analysis of minerals and antioxidant of the samples of the tomatoes where it presents that moisture content (84.46%),

Ash, 6.28%, crude lipid 0.93%, crude protein 1.13%, crude fiber 2.03%, carbohydrate 4.16%, lycopene 10.34 mg/100^, carotene 0.79mg/100^, and terpenes 3.18 mg/100. (Table 1).

Table 2 shows the hematological analysis of the various groups (control and experimental) for the first 21 days it presents that there were significant differences in PCV (t=-2.87, p=0.02), $Hb_{(g/dl)}$ (t= -3.74, p=0.01),), and $RBC_{(g/l)}$ (t= -3.62, p= 0.01), between the control and the experimental groups. While $WBC_{(g/l)}$, $Platelets_{(g/l)}$, Neutrophil (%), Lymphocytes (%), Monocytes (%), Eosinophil (%), Basophil (%) show no statistical significance with the control and experimental groups (p>0.05). Table 3, shows the hematological profile in the last 21 days and it was presented that all the hematological parameters of interest display no significant changes between the control and the experimental groups (p>0.05).

Table 4 shows the effect of Gino tomato paste on the biochemical parameter in the first phase of administration and the findings present that $sodium_{(mmol/L)}$ (t=5.04, p=0.00), bicarbonate (mmol/L) (t=-3.07, p=0.02), $Urea_{(mmol/L)}$ (t=2.79, p=0.02) and $Creatinine_{(mmol/L)}$ (t=4.08, p=0.00) shows statistically significant changes between the control and the experimental group while potassium (mmol/L) and $chloride_{(mmol/L)}$ display no changes (p>0.05). in the last phase, all parameters of interest were significant except $Chloride_{(mmol/L)}$ (Table 5).

Gino tomato paste was analyzed for its proximate and antioxidant components. The proximate components include Moisture Content (83.46%), Ash (6.28%), Crude Lipid (0.94%), Crude Protein (1.13%), Crude Fiber (2.03%,), and Carbohydrates (4.16%). The moisture content in this study was found to be higher than that of Nwakuba et al., [25] whose moisture content ranges for eight different brands of tomato in Nigeria was within (70-80%).

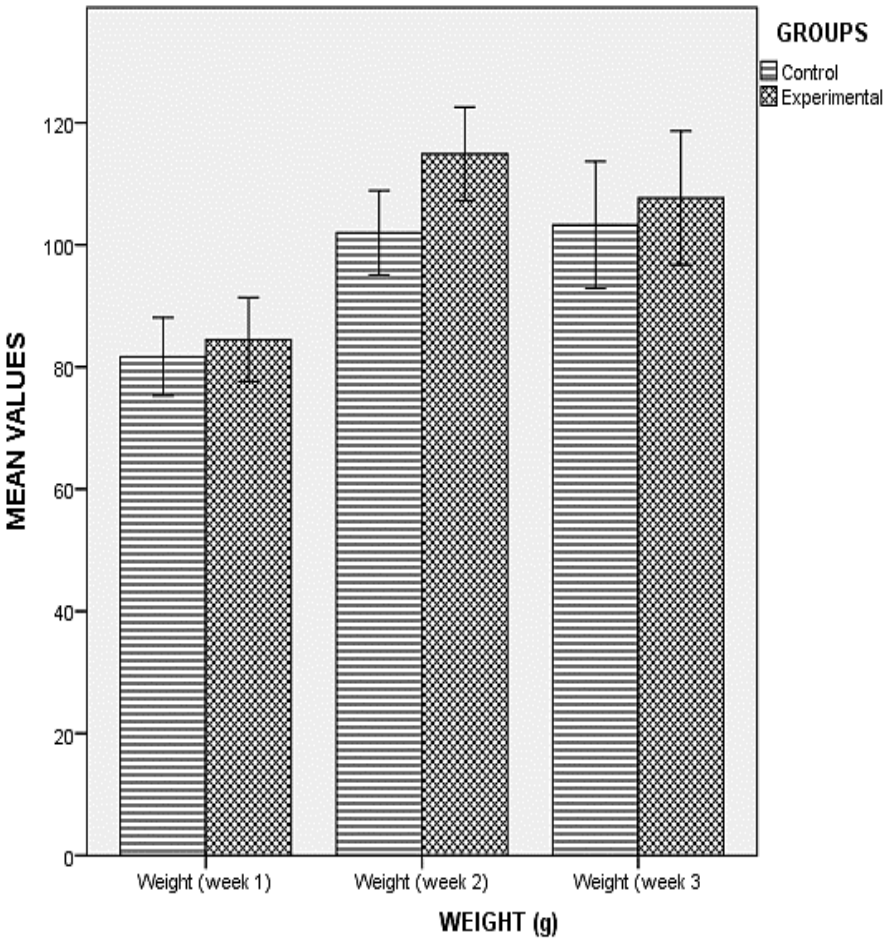


Fig. 1. Weight measurements in both groups for the first 21 days

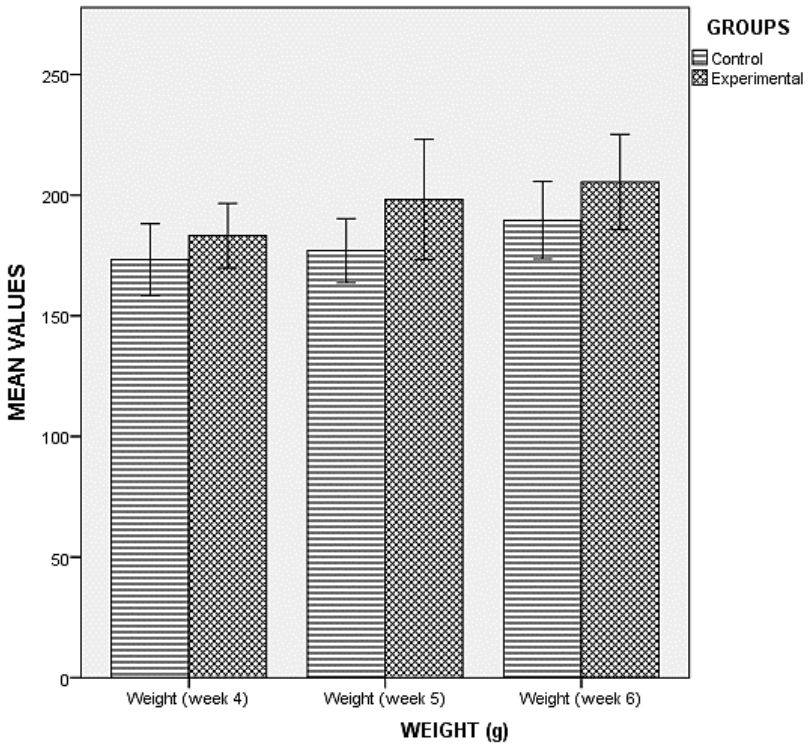


Fig. 2. Weight measurements in both groups for the last 21 days

3.1 Proximate and Antioxidant Analysis of Gino Tomatoes Paste

Table 1. Table showing analysis of mineral and antioxidants

Sample	Tomatoes
Moisture content {%)	83.46
Ash (%)	6.28
Crude Lipid (%)	0.94
Crude Protein (%)	1.13
Crude Fiber (%)	2.03
Carbohydrate (%)	4.16
Lycopene (mg/100^	10.34
Carotene (mg/100^	0.79
Terpenes (mg/100^	3.18

3.2 Hematological Analysis

Table 2. Hematological profile in both groups for the first 21 days of administration

	Groups				
Parameter	**Control**	**Tomato**	**t**	**P value**	**Significance**
PCV (%)	37.00±4.15	53.00±3.69	-2.88	0.02	Significant
Hb (g/dl)	11.70±1.03	17.68±1.22	-3.74	0.01	Significant
WBC g/L	9.44±1.32	7.16±0.50	1.61	0.15	Not significant
RBC g/L	4.30±0.19	5.98±0.42	-3.62	0.01	Significant
Platelets g/L	224.80±20.52	273.60±50.05	-1.13	0.29	Not significant
Neutrophil (%)	26.20±2.65	38.60±5.19	-2.13	0.07	Not significant
Lymphocytes (%)	60.80±3.67	53.80±4.74	1.17	0.28	Not significant
Monocytes (%)	9.80±1.39	5.60±1.63	1.96	0.09	Not significant
Eosinophil (%)	2.80±1.16	1.00±0.63	1.37	0.21	Not significant
Basophil (%)	0.00±0.00	0.00±0.00	-	-	-

Values are presented as Mean±SE. P: The statistical level of significance was determined using the Independent sample T-test. P<0.05 means mean values are significant. SE=Standard Error; n=sample size

Table 3. Hematological profile in both groups for the last 21 days of administration

	Groups				
Parameter	**Control**	**Tomato**	**t**	**P value**	**Significance**
PCV (%)	53.40±2.46	59.60±3.23	-1.53	0.17	Not significant
Hb (g/dl)	17.00±0.56	17.46±0.83	-0.46	0.66	Not significant
WBC*109/L	6.82±0.98	5.44±0.69	1.15	0.28	Not significant
RBC*10'12/L	6.02±0.39	7.30±0.47	-2.11	0.07	Not significant
Platelets*10'9/l	253.40±28.73	357.00±59.99	-1.56	0.16	Not significant
Neutr (%)	30.20±4.61	26.60±1.86	0.72	0.49	Not significant
LMP%	61.00±6.84	66.20±2.56	-0.71	0.50	Not significant
mono %	3.40±0.68	4.60±1.21	-0.87	0.41	Not significant
Eosinophil %	1.20±0.20	2.60±1.25	-1.11	0.30	Not significant
Basophil %	0.00±0.00	0.00±0.00	-	-	-

Values are presented as Mean±SE. P: The statistical level of significance was determined using the Independent sample T-test. P<0.05 means mean values are significant. SE=Standard Error; N=sample size

3.3 Biochemical Analysis

Table 4. Kidney biomarkers in both groups for the first 21 days

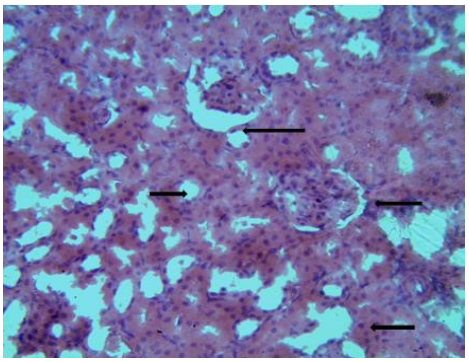
	Groups				
Parameter	**Control**	**Tomato**	**t**	**P value**	**Significance**
Sodium (mmol/L)	136.20±4.85	74.40±11.27	5.04	0.00	Significant
Potassium (mmol/L)	7.28±0.19	11.52±2.15	-1.96	0.09	Not significant
Biocarbonate (mmol/L)	27.80±1.88	50.20±7.04	-3.07	0.02	Significant
Chloride (mmol/L)	75.60±3.85	64.20±6.18	1.56	0.16	Not significant
Urea (mmol/L)	6.08±0.40	3.32±0.90	2.79	0.02	Significant
Creatinine (mmol/L)	225.80±26.00	94.40±19.02	4.08	0.00	Significant

Values are presented as Mean±SE. P: The statistical level of significance was determined using the Independent sample T-test. P<0.05 means mean values are significant. SE=Standard Error; N=sample size

Table 5. Kidney biomarkers in both groups for the last 21 days

	Groups				
Parameter	**Control**	**Tomato**	**t**	**P value**	**Significance**
Sodium (mmol/L)	128.40±3.11	67.40±9.91	5.88	0.00	Significant
Potassium (mmol/L)	13.98±0.36	18.28±2.45	-1.73	0.12	Significant
Biocarbonate (mmol/L)	20.40±1.57	36.60±3.27	-4.47	0.00	Significant
Chloride (mmol/L)	117.40±5.63	106.40±5.24	1.43	0.19	Not significant
Urea (mmol/L)	8.20±0.60	12.50±0.40	-5.94	0.00	Significant
Creatinine (mmol/L)	191.80±3.97	68.60±12.95	9.10	0.00	Significant

Values are presented as Mean±SE. P: The statistical level of significance was determined using the Independent sample T-test. P<0.05 means mean values are significant. SE=Standard Error; N=sample size



FIRST PHASE CONTROL FED WITH STANDARD FED

Fig. 3. Photomicrograph of first phase control group of rat kidney usng h&e @ x400 magnification fed with standard fed for 21 days. Photomicrograph displays normal glomerulus (g), bowman space (bs), proximal convoluted tubule (pct), and distal convoluted tubule (dc)

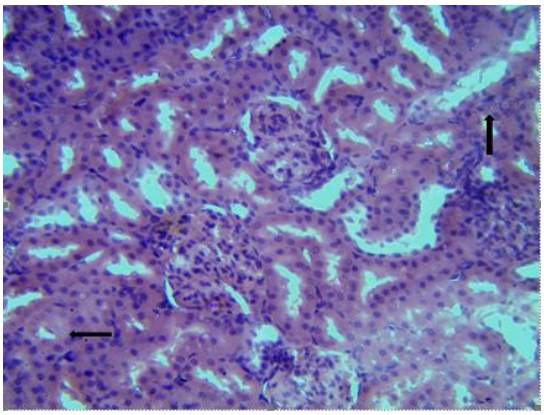


Fig. 4. Photomicrograph of first phase experimental group of rat heart using h&e @ x400 magnification fed with canned tomato paste for 21 days. photomicrograph displays normal glomerulus (g), bowman space (bs), proximal convoluted tubule (pct), and distal convoluted tubule (dc)

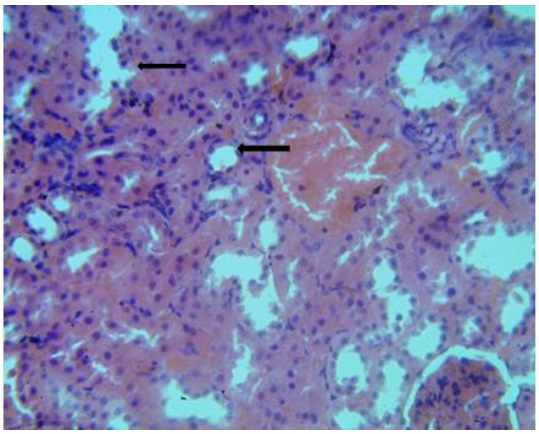


Fig. 5. Photomicrograph of second phases of a control group of rat hearts using h&e @ x400 magnification fed with standard feed for 21 days. photomicrograph displays normal glomerulus (g), bowman space (bs), proximal convoluted tubule (pct), and distal convoluted tubule (dc)

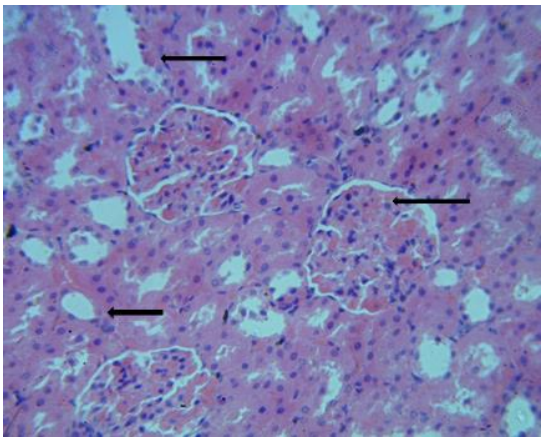


Fig. 6. Photomicrograph of second phases of an experimental group of rat hearts using h&e @ x400 magnification fed with standard feed for 21 days having withdrawn the canned tomato for a recuperation study. photomicrograph displays normal glomerulus (g), bowman space (bs), proximal convoluted tubule (pct), and distal convoluted tubule (dc)

The hematological indices such as Packed Cell Volume (PCV), hemoglobin counts (HB), White Blood Cell (WBC), Platelets, Red Blood Cells (RBC), neutrophils, lymphocytes, monocytes, eosinophils of Wistar rats fed with Gino tomatoes were studied, Out of all 10 only 3 were found to be statistically significant they include; PCV, Hb, and RBC. According to the work done by Sharma et al., [26] tomato is proven to have significant effects against Wistar rats hematology. These studies correspond with the increase of hemoglobin levels found in the rats during the period of administration of tomatoes. The result from this study also shows that there is a relationship between Hb, PCV, and RBC. This conforms with the studies done by Bain and Bate, [27] who stated that Hb is one-third of PCV. This was found to be so as the value for PCV in the experimental group =53 and one-third of 53 = 17.6 which is the value of Hb in the experimental group. Meanwhile, during the Last 21 days recuperation period none of the parameters were found significant, including PCV, Hb, and RBC were formerly statistically significant in the first 21 days of administration of tomatoes. One could say the consumption of tomato paste has an effect concerning elevating the PCV, Hb, and RBC levels.

All tested parameters came out statistically significant except Potassium (K) and Chloride (Cl-) in the first 21 days. It was also found that though potassium and Chloride were not statistically significant, there was an increase in potassium in the experimental group against potassium in the control group with values (11.52±2.15) and (7.2±0.19) (table 4). This harmonizes with the studies carried out by Krouwer and Monti, [28] who said that hyperkalemia (a condition where Potassium is above the normal range) can occur as a result of excessive dietary intake of tomatoes.

During the recuperation phase, all parameters including Potassium were found to be statistically significant except Chloride with Mean±SEM (117.40±5.63) and (106.40± 5.24) for the control and experimental group respectively. The weight changes among various groups throughout the experiment. After the first 21 days, when compared against the control group it was observed that there was a statistical/significant difference in week 3. Further investigations after the second 21 days also indicated no significant statistical difference across the different groups. These findings were also found to be consistent with the works of Almario et al., [29], who carried out a study on the effects of walnut consumption and found out that after consuming 48g of walnut for six weeks there was no significant weight gain.

Histologically it was observed from the slide in Fig. 5 that there were no observable pathological changes of the normal kidney as against the kidney of tomato administer rats

4. CONCLUSION

The consumption of tomato paste (Gino) shows an effect on renal marker Potassium (K) as it increases the potassium level, hence persons with underlying kidney issues may need to be mindful of their tomato consumption. The study also shows that tomato consumption increases Hemoglobin (Hb), Pack Cell Volume (PCV), and Red Blood Cells (RBC) levels in the blood, therefore tomato or a diet rich in tomatoes may be recommended for a person with low Hb, PCV, and RBC.

CONSENT

It is not applicable.

ETHICAL APPROVAL

The study was authorized by the Faculty Research Committee of Basic Medical Sciences at the University of Port Harcourt, Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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