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Effects of Yaji on Some Biochemical and Haematological Indices in Albino Wistar Rats

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Abstract: *Yaji* is a mixture of spices and additives that is used as sauce for meat delicacy in Nigeria called *suya*. Its effects on the body weight, index of liver function, on lipid profile, kidney function and some haematological indices were the main focus of this study. A total of 50 Wistar rats with average weight of 200grams were randomly divided into five experimental groups: A, B, C, D and E. Each group consisted of ten animals. Baseline blood sample was collected from each animal. Group A was the control group while groups B to E were the treatment groups. Group A was given 100% chicken mesh, group B with 75% of chicken mesh + 25% of *yaji*, group C with 50% of chicken mesh + 50% of *yaji,* group D with 25% of chicken mesh + 75% of *yaji,* group E with 100% of *yaji*. The experiment lasted for 30days. There was a significant increase in some atherosclerotic index: Total Cholesterol (TC) and Triglyceride (TG), while the level of Low Density Lipoprotein (LDL) only increased at very high percentage of *yaji* intake but High Density Lipoprotein (HDL) increased at moderate intake of *yaji*. Sodium and Chloride ions were significantly increased while Potassium and Bicarbonate ions decreased significantly compared to the controls with urea and creatinine levels remaining unchanged. There was also a significant decrease in Packed Cell Volume (PCV) as the proportion of *yaji* increased in relation to their feed while White Blood Cell Counts, total and differential were unchanged. The changes in weight did not show any statistical difference from the control. The consumption of the meat sauce, *Yaji* and its spices may have adverse health implications if consumed in higher quantity than the normal diet and therefore should be consumed only occasionally.

Keywords: *Yaji*, Aspartate and Alanine Amino Transferases, Alkaline Phosphatase, Total Cholesterol, High Density Lipoprotein, Low Density Lipoprotein, Serum Electrolytes, Urea and Creatinine

1. Introduction

1.1. Background

There is a growing concern about the indiscriminate and massive consumption rate of *Yaji*, which, in recent years, has been the basis of several scientific investigations [1]. Some of the findings from such investigations show that an excessive consumption of *Yaji* has the capability to induce pancreatic, liver, kidney and brain damages [2]. These findings further illuminate the fears that an unregulated production and consumption of *Yaji,* portends serious dangers to the health of its consumers. Of importance also, are the reports that some of the active ingredients in *Yaji,* like capsaicin, piperine and monosodium glutamate possess excitotoxic and apoptotic potentials [3, 4].

This Nigerian meat sauce known as *Yaji* is a complex

physical mixture of groundnut cake powder, additives, spices and salt [5]. Its main constituent is the groundnut cake, while the constituent spice-ginger, garlic, clove, red pepper and black pepper [6] contains gingerol [7], allicin, eugenol [8], capsaicin [9] and piperine [10] as active principles respectively.

Gingerol, which is an active component in ginger has been used to induce a hypothermic state in rats [11] and seems to be effective in an animal model of rheumatoid arthritis [12]. Gingerol has also been investigated for its effect on cancerous tumours in the bowel [13], breast tissue [14], ovaries [15], the pancreas, among other tissues with positive results.

Eugenol, the main component found in cloves has been found to kill certain human colon cancer cell lines in vitro but has also been documented to be hepatotoxic [16]. Overdose is possible, causing a wide range of symptoms from blood in the patient's urine, to convulsions, diarrhoea, nausea, unconsciousness, dizziness, or rapid heartbeat [17].

Capsaicin is used to treat minor aches and pains of the muscles and joints (e.g. arthritis, backache, sprains). It may also be used to treat nerve pain but causes severe dizziness and respiratory distress as side effect [18].

Capsaicin is actually an irritant to humans, producing a burning sensation in any tissue it touches. It works by depleting or interfering with autocoids such substance P, a chemical involved in transmitting pain impulses to the brain. The properties of capsaicin make it an option for relieving pain associated with osteoarthritis, rheumatoid arthritis, and diabetic neuropathy [19].

Piperine, the active component of black pepper is involved to increase the absorption of other nutrients in the body and has other novel applications as well - such as helping to fight gastrointestinal cancer and having a central nervous system effect while enhancing the cognitive functions of the brain [20].

Black pepper contains several potent antioxidants and is thus one of the most important species for preventing and curtailing oxidative stress. This complex mixture of spices and additives has active ingredients which on individual basis, are known to have side effects if consumed in excess. The growing concern is that the excessive consumption of *Yaji* signifies an excessive consumption of a combination of these constituents which are mixed without a standardized format [6].

1.2. Rationale for Study

The in vivo effects of consumption of *Yaji* to the health of its consumers have been of interest in several quarters. Thus, it is needful to ascertain the safe use or otherwise of *Yaji* meat sauce since its production and consumption are yet to be regulated.

1.3. Statement of Problem

By virtue of the powerful phytochemicals they contain, these additives and spices are known to exhibit an array of biochemical and pharmacological activities including antioxidant and anti-inflammatory properties that are believed to contribute to their anticarcinogenic and antimutagenic activities [21].

2. Materials and Methods

2.1. The Substance of Study

The local meat sauce *Yaji* and its constituent spices: clove, ginger, garlic black pepper, red pepper and monosodium glutamate (*ajinomoto)* were purchased from Nkwo market, Nnewi, Anambra State and identified by a taxonomist, Mr NwaruChijioke Maxwell of the Botany Department, NnamdiAzikiwe University Awka Campus. Also, animal feeds in the form of chicken mesh were bought from the same market. The spices and animal feeds were crushed separately using an electric blender. Measurement of spices was carried out using electric balance.

2.2. Proportions of Components of Yaji

Ground nut cake powder (*Yaji)* 50%, Ajinomoto/Monosodium Glutamate 10%, Ginger10%, Cloves 10%, Garlic cloves 10%, Black pepper5%, Red pepper5%. *Yaji* as a meat sauce is a local preparation; therefore the quantity of constituents may differ in some localities. However, the proportion used in this study was got from an interview with some individuals from the Northern states of Nigeria who are the main producers of suya and its sauce, *yaji* that have their business centres (*suya* spots) located at Eke Amobi, Izuchukwu park and Abada junction, all in OtoloNnewi.

Fifty-five adult male rats weighing 180g to 220g were obtained and maintained in the laboratory. They were acclimatized to the laboratory conditions two weeks before the start of experiment and caged in a room temperature. The rats were fed according to their group diet and water *ad libitum.* Five of these acclimatized animals were sacrificed for baseline parameters viz: serum lipid profile, liver function test urea and creatinine assessment.

The study was conducted in the animal house of NnamdiAzikiwe University Okofia Campus, Nnewi.

2.3. Study Design

The rats were randomly divided into five (5) experimental groups: A, B, C, D and E. Every group consisted of ten (10) animals. Group A was the control group while groups B to E were the treatment groups. Group A was given 100% chicken mesh, group B was fed with 75% of chicken mesh + 25% of *Yaji*, group C was fed with 50% of chicken mesh + 50% of *Yaji,* group D was fed with 25% of chicken mesh + 75% of *Yaji,* group E was fed with 100% of *Yaji*. All the feed were prepared into pellets prior to administration. Food and water were supplied *ad libitum*. The experiment lasted for 30days.

Baseline samples were collected at the beginning of the experiment and at the end of the experiment, the rats were sacrificed and blood was collected. The blood was collected in both plain bottles and Ethylene Diamine Tetra acetic Acid (EDTA) bottles for biochemical and haematological analysis respectively.

The source of water was pipe-borne water (tap water).

2.4. Analytical Methods

The plasma concentration of Triglyceride, Total cholesterol and High Density Lipoprotein-Cholesterol (HDL-C) were measured using standard spectrophotometric methods.

Serum total cholesterol is determined by enzymatic method as described by Allain*et al.,* (1974).

Serum triglyceride is determined using an enzymatic colorimetric method as described by Bucolo and David; (1973).

Serum HDL-cholesterol is determined using precipitation method as described by Benzie, (1979).

Serum LDL-cholesterol is determined using Friedwald's formular as described by Friedewald et al., (1972) method.

Serum alanineaminotransferaseis determined using spectrophotometric method as described by Reitman and Frankel, 1957.

Serum aspartateaminotransferaseis determined using spectrophotometric method as described by Rietman and Frankel, (1957).

Serum alkaline phosphate is determined using spectrophotometric method (Bessey et al., 1972).

The white cell count (WBC) is determined by the total number of leukocytes in a volume of blood as described by Dacie and Lewis (2001).

Packed Cell Volume was determined by centrifuging anti-coagulated blood in a glass capillary as described by Cheesbrough (2002).

Electrolytes estimation as described by Martin Frank, 1994.

Blood urea concentrations estimation by Berthelot's reaction as described by Kaplan and Teng (1982).

Creatinine Estimation using the Reflotron Dry Chemistry Analyzer as described by Estridge*et al*, 2000.

2.5. Data Analysis

Results of the experiment were subjected to a one way Analysis of Variance (ANOVA) using statistical package for social sciences (SPSS) version 16 and presented as Mean ± Standard Deviation. The means of all the test groups and the control (group A) were compared for four weeks. Values of $p < 0.05$ were considered statistically significant.

3. Results

Table 1. *Lipid profile before and after intake of different proportions of yaji in albino wistar rats.*

		Mean ± SD N =5				
		Group A	**Group B**	**Group C**	**Group D**	**Group E**
		100% feed	**25% *yaji***	**50% *yaji***	**75% *yaji***	**100% *yaji***
T. C	Baseline	2.27 ± 0.02	2.25 ± 0.05	2.29 ± 0.02	2.26 ± 0.03	2.26 ± 0.03
	After	2.25 ± 0.02	2.26 ± 0.03	2.6 ±0.04	3.26 ± 0.22	5.21 ± 0.14
	Paired t-test	2.16	-0.38	-21.83	-9.74	-41.76
	p-value	0.097	0.721	0.000*	0.001*	0.000*
HDL-C	Baseline	1.26 ± 0.01	1.25 ± 0.02	1.25 ± 0.02	1.25 ± 0.01	1.25 ± 0.02
	After	1.33 ± 0.05	1.20 ± 0.06	1.28 ± 0.03	1.40 ± 0.03	1.51 ± 0.06
	Paired t-test	-3.21	1.66	-1.38	-12.52	-13.46
	p-value	0.032*	0.172	0.24	0.000*	0.000*
LDL-C	Baseline	0.77 ± 0.03	0.76 ± 0.02	0.77 ± 0.02	0.77 ± 0.03	0.77 ± 0.03
	After	0.95 ± 0.14	0.75 ± 0.07	0.65 ± 0.04	0.62 ± 0.06	1.56 ± 0.10
	Paired t-test	-2.45	0.25	12.51	3.8	17.07
	p-value	0.071	0.817	0.000*	0.019*	0.000*
TG	Baseline	0.48 ± 0.02	0.48 ± 0.02	0.47 ± 0.02	0.48 ± 0.02	0.46 ± 0.04
	After	0.44 ± 0.03	0.31 ± 0.08	0.25 ± 0.05	1.13 ± 0.22	2.23 ± 0.32
	Paired t-test	2.59	4.95	7.83	-6.33	-11.84
	p-value	0.061	0.008*	0.001*	0.003*	0.000*

* Shows that the level is significant ($p<0.05$)

TC: Total Cholesterol (mmol/l) - Groups C, D, E significantly elevated

HDL-C: High Density Lipoprotein (mmol/l) - Groups A, D, E significantlyelevated

Elevated: Low Density Lipoprotein (mmol/l) - Groups C, D, E significantly reduced

TG: Triglyceride (mmol/l) - Groups C, D significantly reduced, E elevated

Table 2. *The results of liver enzymes before and after intake of different proportions of yaji in albino wistar rats.*

		Mean ± SDN =5				
		Group A	**Group B**	**Group C**	**Group D**	**Group E**
		100% feed	**25% *yaji***	**50% *yaji***	**75% *yaji***	**100% *yaji***
AST	Baseline	10.7 ± 0.5	10.6 ± 0.4	10.6 ± 0.4	10.7 ± 0.6	10.8 ± 0.17
	After	10.1 ± 0.2	11.2 ± 0.2	11.4 ± 0.4	11.8 ± 0.2	13.3 ± 0.5
	Paired t-test	1.73	-1.86	-2.64	-5.33	-8.43
	p-value	0.159	0.137	0.058	0.006	0.001*
ALT	Baseline	10.2 ± 0.1	10.5 ± 0.2	10.3 ± 0.2	10.4 ± 0.1	10.3 ± 0.2
	After	10.6 ± 0.3	11.1 ± 0.4	11.6 ± 0.3	11.4 ± 0.1	12.7 ± 0.3
	Paired t-test	-2.75	-3.26	-11.43	-26	-9.75
	p-value	0.052	0.031*	0.000*	0.000*	0.001*
ALP	Baseline	33.2 ± 0.4	33.1 ± 0.4	33.0 ± 0.3	32.6 ± 0.5	32.9 ± 0.22
	After	33.0 ± 0.8	34.1 ± 0.4	34.4 ± 0.4	34.7 ± 0.31	35.6 ±0.36
	Paired t-test	0.69	-3.71	-8.49	-17.49	-15.2
	p-value	0.526	0.021*	0.001*	0.000*	0.000*

* Shows that the level is significant ($p<0.05$)
AST - Aspartate amino Transferase (iu/l) - Group E significantly elevated
ALT - Alanine amino Transferase (iu/l) - Groups B, C, D, E significantly elevated
ALP - Alkaline Phosphatase (iu/l) - Groups B, C, D, E significantly elevated

Table 3. *The results of renal profile before and after intake of different proportions of yaji in albino wistar rats.*

		Mean ± SDN =5				
		Group A	**Group B**	**Group C**	**Group D**	**Group E**
		100% feed	**25% *yaji***	**50% *yaji***	**75% *yaji***	**100% *yaji***
UREA	Before	5.76 ± 0.7	5.48 ± 0.8	5.48 ± 0.8	5.94 ± 0.5	6.32 ± 0.8
	After	5.70 ± 0.7	5.44 ± 0.7	5.48 ± 0.6	5.90 ± 0.5	6.28 ± 0.6
	Paired t-test	0.51	0.23	0	0.3	0.14
	p-value	0.634	0.828	1	0.778	0.896
Cr	Before	113.2 ± 0.9	113.6 ± 0.7	113.8 ± 0.8	112.8 ± 2.0	113.3 ± 0.5
	After	113.6 ± 0.5	113.1 ± 0.6	113.6 ± 0.8	112.9 ± 2.0	113.4 ± 0.5
	Paired t-test	-1	0.9	0.89	-0.89	-0.33
	p-value	0.373	0.419	0.426	0.426	0.757

Urea mmol/l
Creatinine mg/dl

Table 4. *The results of electrolytes with different proportions of yaji in comparism with control in albino wistar rats.*

Parameters/Groups	**Mean ± SDN =5**			
	Sodium mmol/l	**Chloride mmol/l**	**Potassium mmol/l**	**Bicarbonate mmol/l**
100% feed (control)A	142.80 ± 2.168	96.00± 1.000	4.44 ± 0.167	23.80 ± 1.304
25% yaji&75%feedB	146.40 ± 1.34	97.6 ± 2.30	4.160 ± 0.114	23.60 ± 1.140
50% yaji&50% feedC	148.60 ± 1.67a	103.6 ± 1.52a	3.900 ± 0.255a	22.20 ± 1.095
75% yaji&25% feedD	163.80 ± 2.78a	114.2 ± 3.11a	3.600 ± 0.200a	21.40 ± 0.510a
100%yajiE	177.60 ± 2.88a	116.6 ± 1.82a	3.180 ± 0.110a	21.00 ± 1.225a
F – value	209.59	102.76	37.892	5.714
P – value	0	0	0	0.003

a = significance when compared with control

Table 5. *The results of packed cell volume and white blood cell count with different proportions of yaji in comparism with control in albino wistar rats.*

Parameters/Groups	**Mean ± SDN =5**			
	PCV %	**NEUT (%)**	**LYMPH (%)**	**MONO (%)**
100% feed (control)A	41.60 ± 3.58	41.40 ± 2.191	49.40 ± 1.140	8.40 ± 1.817
25% yaji&75%feedB	39.60 ± 1.673	41.40 ± 2.074	48.80 ± 1.789	9.40 ± 3.782
50% yaji&50% feedC	38.40 ± 1.673	42.20 ± 1.789	48.60 ± 1.140	9.20 ± 1.643
75% yaji&25% feedD	33.60 ± 1.673a	42.60 ± 1.949	47.80 ± 1.095	8.80 ± 1.304
100%yajiE	26.40 ± 1.673a	42.16 ± 1.993	45.60 ± 2.510	10.00 ± 1.581
F – value	38.533	0.731	4.113	0.376
P – value	0	0.582	0.014	0.823

a = significance when compared with control

Table 6. *The weight of rats with different proportions of yaji in comparism with control assessed before and after four weeks consumption of yaji.*

	1st week	4th week	Paired t-test	P-value
100% feed	198.00 ± 17.90	226.00 ± 26.08	1.633	0.178
25% *yaji*	194.00 ± 8.94	216.00 ± 20.74	3.207	0.033*
50% *yaji*	183.00 ± 4.47	194.00 ± 19.49	2.582	0.061
75% yaji	203.00 ± 10.95	196.00 ± 20.74	2.449	0.07
100% *yaji*	197.00 ± 4.47	196.00 ± 8.94	1	0.374

* Shows that the level is significant ($p<0.05$)

Table 7. *The weight of rats with different proportions of yaji in comparism with control in albino wistar rats.*

Parameters/Groups	Mean ± SDN =5			
	WT IN Kg WEEK 1/ BASELINE	WT IN Kg WEEK 2	WT IN Kg WEEK 3	WT IN Kg WEEK 4
100% feed (control)A	198.00 ± 17.90	196.00 ± 35.78	214.00 ± 2.93	226.00 ± 26.08
25% yaji&75%feedB	194.00 ± 8.94	184.00 ± 16.73	194.00 ± 15.17	216.00 ± 20.74
50% yaji&50% feedC	183.00 ± 4.47	166.00 ± 8.944	184.00 ± 15.17	194.00 ± 19.49
75% yaji&25% feedD	203.00 ± 10.95	206.00 ± 21.91	200.00 ± 14.14	196.00 ± 20.74
100%yajiE	197.00 ± 4.47	194.00 ±8.94	202.00 ± 10.95	196.00 ± 8.94
F – value	2.478	2.605	1.942	2.635
P – value	0.077	0.067	0.143	0.065

4. Discussion

Results of the serum lipid profile, Total Cholesterol (TC), Triglycerides (TG), Low Density Lipoprotein (LDL) as well as in High Density Lipoproteins (HDL) in rats; show that there was a progressive increase in the Total Cholesterol as the dosage of *Yaji* increased from 25% to 100%. This could be attributed to the high proportion of groundnut (*Arachis hypogeal L*) cake which forms 50% of the entire *Yaji* preparation. Groundnut cake is rich in fats and oil [22, 23] which is a rich source of lipids. These high levels of fats and oil in the groundnut cake may overwhelm the rats' enzymes responsible for lipid metabolism, hence the significant increase in all the serum lipids estimated compared to baseline values. Another possible explanation for the rise in serum lipid profile is that *Yaji*, a complex mixture of constituents also contains Monosodium Glutamate (MSG). It has been reported that MSG alters the regulatory mechanism that affects fat metabolism [24]. This study also shows that *Yaji* as a complex mixture has the potentials to induce weight loss, though not statistically significant. This can be attributable to the fact that this meat sauce can induce appetite but cannot supply adequate body requirements needed for daily activities.

Groups B and C had decreased TG compared to baseline, Groups D and E had increase in TG. There was also a decrease in LDL in Groups C compared to baseline. The Group C rats were fed with 50% *Yaji* and a reduction in LDL is a good value for cardiovascular health. This may be due to the constituents found in *Yaji*, such as garlic which has been reported to lower blood cholesterol [25, 26].

This study also shows that *Yaji* as a complex mixture has the potentials to induce weight loss, though not statistically significant. This can be attributable to the fact that this meat sauce can induce appetite but cannot supply adequate body requirements needed for daily activities.

The weight changes could be due to change in diet.

My study on the biochemical changes in rats after *Yaji* consumption showed varied degree of changes in the electrolytes (Sodium, Potassium, Bicarbonate and Chloride ions) estimated. The results of this study have also shown that *Yaji* has the potential to alter the values of Packed Cell Volume (PCV). This response to the ingestion of *Yaji* in a proportion higher than the normal feed is suggestive of the fact that the constituents of *Yaji* in combination can induce anemia.

5. Conclusion

This study showed that the consumption of *Yaji* in large amounts could cause liver damage, anaemia, electrolyte derangement and could also affect fat metabolism. There was no effect on the urea and creatinine levels. *Yaji*, as a meat sauce could be consumed with the normal diet in moderate quantity compared with the daily diet and not to be used as a substitute for food as this could cause a reduction in weight. It follows that the consumption of *Yaji* in excess could cause injury to some vital cells (such as the liver) with subsequent release of these enzymes into the blood stream. If the consumption of large amount of *Yaji* should be prolonged, organ damage may likely set in.

6. Recommendation

These findings are observed in animals; similar studies could be done in humans to correlate these findings, but before then the consumption of *Yaji* should be done in moderation and with caution; as the findings in the animals may not be different if extrapolated to humans.

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