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Bitter Cassava Juice (Linamarin) and Its Effect on Renal Function Parameters in Konzo-Induced Wistar Rats in Nigeria

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ABSTRACT

The aim of this study is to elucidate the effect of bitter cassava juice (linamarine) on renal function parameters in Konzo-Induced Wistar rats. Twenty-five (25) adult female wistar rats were divided into five groups of each having 5 rats, Group 1 served as control, were fed with animal feed and water only, group 2 were given bitter cassava and water, group 3 were given 4.7 ml of linamarin, group 4 were given 2.7 ml of linamarin, group 5 were given 0.7ml of linamarin orally for a period of five weeks. The animals were sacrificed and samples analyzed in the laboratory. The results showed a statistical significant at p≤0.05 when compared with the control. Potassium showed significant increase across all the groups treated with bitter cassava induced-konzo and Linamarin compared to the control, revealed significant increase of sodium allthrough the groups treated with bitter cassava induced-konzo and Linamarin compared with the control, revealed an increase of bicarbonate across all the groups treated with linamarin except the group 2 treated with bitter cassava induced-konzo which has a decrease. Statistically, result also showed a significant increase Urea and Creatinine levels in groups 3 and 4 with a significant decrease in groups 2 and 5. The increase observed in urea and creatinine indicates that kidney function would deteriorate as it prolongs which is in accordance with a study carried out by Nehli et al (1994). Hence, the finding of is study has further confirm the effects of bitter cassava induced-konzo and Linamarin on renal functions of using wistar rats model and is in line with Hirsjarvi et al., 1990.

Keywords: *Cassava juice; Wistar rats; Renal Function; Animal.*

1.0 Introduction

African countries including Nigeria consume a lot varieties of meals as source of carbohydrate derived from cassava plants as staple food regularly because of its drought tolerance, high production on poor soils, and ability to leave the starch-rich tubers in the soil for lengthy periods of time and so harvest on demand (Nweke et al., 2002). Garri and tapioca which are food derivatives of cassava are mostly e with soup or sip with water as their major meals by the people of Abua/Odual Local government area in Rivers state, southern Nigeria. The cassava plant is of diverse species such as 419 bitter cassava are commonly consumed by African and Nigerians. The leaves and roots of cassava plant contain linamarin, an acetone cyanohydrin glucoside which is believed to have a role in the movement of nitrogen from young plants' leaves to roots while also acting as a plant defense mechanism. Linamarase, an enzyme that is generated when the cells of cassava roots are ruptured, reacts with linamarin to transform it into harmful hydrocyanic acid or prussic acid, the Val- and Ile-derived cyanogenicglucosides, linamarin and lotaustralin, are present in all portions of the cassava plant in a ratio of around 97:3 (Lykkesfeldt and Mller, 1994).Cassava plant has a large amount of linamarin in the leaves and in the skin of the root but Sweet cassava has a small amount of linamarin in the inner part of the root called the parenchyma and bitter cassava has a much larger amount. The bitter taste is mainly due to linamarin but there are other bitter compounds in the root and also sour constituents, which sometimes confuses the taste

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buds. The total cyanide content of the parenchyma of different cassava varieties ranges from 1 mg HCN equivalents / kg fresh root (1 ppm) to 1550 ppm. In Nigeria one variety is called “chop and die”. The parenchyma from sweet cassava is cooked and eaten whereas that from medium and high cyanide cassava must be processed into products such as flour and garri.

Cassava leaves are used widely in tropical Africa. They are a good source of protein and vitamins but contain large amounts of linamarin that is traditionally removed by pounding followed by boiling in water. When linamarin is exposed to linamarase, an enzyme often expressed in the cell walls of cassava plants, cyanide is typically produced from linamarin by an enzymatic process. Foods manufactured from cassava are often produced after prolonged blanching, boiling, or fermentation since the cyanide compounds that come from these processing processes are volatile. Garri (toasted cassava tubers), the porridge-like fufu, the dough agbelima, and cassava flour are all foods derived from cassava plants. Researchers have created a transgenic cassava plant that uses ribonucleic Acid (RNA) interference to steadily down regulate the production of linamarin. More than 80% of the cassava cyanogenicglucosides are linamarin. It is a ß-glucoside of ethyl-methyl-ketone-cyanohydrin and acetone cyanohydrin.

Linamarin’s ß-linkage is easily broken by enzymes, but it can only be disrupted under conditions of extreme pressure, heat, and application of mineral acids. This ß-linkage can be broken by the natural cassava enzyme linamarase. Optimal conditions for the enzymatic process are 25 oC and a pH range of 5.5 to 6.0. The cassava plant contains linamarin in all of its components, however it is more concentrated in the root and leaves. A good detoxification can happen if the enzyme and substrate are combined.

Cooke (1979) claims that the two distinct cyanogenicglucosides in cassava plants are linamarin and lotaustralin. These compounds are then carried to the tubers, where they can build up to 1.5 g kg1 dry weight (Bokanga, 1994; Jrgensen et al., 2005a). The apoplast is one of the many tissues or subcellular compartments in plants where cyanogenicglucosides and particular -glucosidases that can cleave the -glucosidic bond are segregated (Morant et al., 2008). This is a two-component system that is activated in response to cellular disruption (such as that caused by chewing insects or food processing). Following the activity of the -glucosidase, the cyanohydrin that was created dissociates into a poisonous ketone and HCN.

The largest concentration of linamarin is found in the roots and leaves (Vitti, Figueiredo and Angelucci 1972). The poisonous chemical hydrogen cyanide (HCN), which is produced by linamarin, poses a risk to consumers while toxicity brought on by glucoside has not yet been documented, toxicity brought on by free cyanide (CN) has. According to Oke (1969), linamarin and lotaustralin are respectively the ß-glucosides of acetone cyanohydrin and ethyl-methyl-ketone-cyanohydrin. The most prevalent glucoside in cassava, accounting for nearly 80% of all glucosides, is linamarin. According to

Anderson et al. (2000), the shoot apex is where the majority of the cyanogenicglucosides are produced. These compounds are then transferred to the tubers, where they can build up to 1.5 g kg1 dry weight. In impoverished areas where cassava is the only accessible staple crop, the presence of cyanogenicglucosides in cassava poses a significant nutritional disadvantage. As sulfur amino acids are necessary for cyanide detoxification, consumption of incompletely processed cassava-derived products in combination with an unbalanced diet low in sulfur amino acids may result in chronic cyanide intoxication (Padmaja G., 1995). In the worst-case scenarios, this could lead to deadly conditions including tropical ataxic neuropathy and konzo (Banea-Mayambu et al., 1997; Oluwole et al., 2000).

The cassava plants Konzo is an upper motor neuron disease that causes irreversible paralysis of the legs and occurs mainly in children and young women of child-bearing age. The Yaka tribe in the Democratic Republic of Congo (DRC) gave the name “Konzo,” which means bound legs, to describe a fetish used by hunters to weaken legs and trap wild animals. Konzo has been well-known to the Yaka natives of the Bandundu province in Zare, now known as the DRC, since the end of the 19th century. However, the condition was not originally described in the medical literature until man year’s later (Van der Beken, i1993). Since then, Konzo outbreaks have been reported in numerous other sub-Saharan African nations, including Mozambique ii(where it is

known as mantakassa), Tanzania, Central African Republic ii(CAR), Cameroon, Angola, and the Democratic Republic of the Congo ii(DRC)I (Chabwine et al., 2011;Ciglenecki et al., 2011; Cliff et al.,2011;iiMlingi et al., i2011 While there may be individual incidences of the illness, it often manifests as an epidemic that is thought to be brought on by emergency events like hunger, civil conflicts, or drought.

Agroecological collapse, Konzo epidemics, and intake of improperly processed bitter cassava (Manihot esculenta Crantz), a staple food for many people in sub-Saharan Africa, have all been linked in the majority of epidemiological research. Despite the fact that Konzo may affect both men and women, adult males are less likely to be impacted, and no research have shown that Konzo can harm children under the age of two.

For unidentified causes, the condition predominantly affects people over the age of three and women who are reproductive (Cliff et al., ii2011; Mlingi et al., i2011; Tylleskar eti al., 1995; Tylleskari et al., 1992; OkitunduLuwa et al., 2014; Nzwalo & Cliff, 2011).iKonzo has been projected to afflict hundreds of thousands of people, with the bulk of instances taking place in the DRC. Because of imprecise demographic data and inadequate monitoring methods, it has been challenging to get accurate prevalence estimates (up to 5% in certain rural regions) (Tshala-Katumbay et al., 2013).The paralysis occurs quite suddenly, does not progress over time and is irreversible. It is associated with the consumption of a monotonous diet of high cyanide (bitter) cassava, by poor rural people in Africa, many of whom suffer from malnutrition.

Specifically, konzo is associated with a high cyanide diet of bitter cassava consumed over a period of several weeks combined with a low intake of protein, particularly a shortfall of essential S-containing amino acids that are needed to detoxify cyanide to thiocyanate in the body. Konzo is an upper motor neuron disease with a sudden onset of symmetrical spastic paralysis that is permanent but not progressing. Children and mothers who are close to having children are most affected.

The neurological symptoms of Konzo patients remained consistent throughout time, although there was evidence of functional improvement (Cliff and Nicala, 1997). Ankle clonus and high urine thiocyanate concentrations were also noted, the mitochondrial cytochrome aa3 oxidase is rendered inactive by acute cyanide overdose, which prevents cells from respiring (Nelson, 2006).

Unfortunately, meticulous processing of cassava tubers to remove the cyanide-generating components causes a concurrent loss of proteins, vitamins, and minerals, considerably lowering the nutritional value of this crucial crop (Maziya-Dixon et al., 2009). According to O'Brien et al. (1991) after cassava roots are processed, the hydrolytic enzyme linamarase is still active and catalyzes the reaction that releases one molecule each of glucose, acetone, and hydrocyanic acid.

The ideal pH range for linamarase is 5.5 to 6.0. ß-hydrolytic enzyme-producing microorganisms can also hydrolyze glucosides (Oke, 1969). Experimental results showed that the average lethal dose of cyanide for higher animals was expressed as milligrams per kilogram (mg/kg) of living weight. Oke (1969) determines that 1 mg/kg of living weight is the fatal dose. Therefore, based on the amount of cyanide in the root, cassava roots are divided into dangerous and non-toxic categories. Therefore, the root is considered dangerous if the cyanide level is high enough to exceed such an average dose. Hydrocyanic acid levels in cassava roots have been reported to range from 15 to 400 ppm (mg CN/kg of fresh weight), but values between 30 and 150 ppm are most frequently seen. There are other cassava cultivars with cyanide (CN).

Animals typically have a detoxifying system that prevents them from dying when the release of cyanide is slow. Swines (monograstic with a stomach pH of 3.0) and bovines (polygrastic with a stomach pH of 7.0) both have this mechanism, depending on the pH (Oke, 1969), Because of their anaerobic metabolism, alternate respiratory chain metabolism, and ability to detoxify cyanide by splitting the CN radical into carbon and nitrogen, microorganisms may thrive in substrates that contain cyanide.

Only the monocotyledonous crop great millet (Sorghum bicolor; Jones et al., 1999) has the enzymes and related genes for the whole cyanogenicglucoside biosynthesis pathway discovered. The aromatic cyanogenicglucosided-hurrin is found in great millet. Genetically speaking, the dhurrin pathway is straightforward because it is entirely encoded by just three structural genes. The interaction of cyanide with iron (Fe), which results in the creation of cyanohemoglobin, causes toxicity in

higher animals. Cyanide blocks electrical transport and, as a result, the production of ATP (adenosine triphosphate) in higher plants and microorganisms (Nartey, 1981). This interference occurs through cyanide's combination with cytochrome oxidate.

However, consumption of acetone cyanohydrin, linamarin's breakdown product, is thought to cause the toxicity (Banea-Mayambu, et al, 1997). Cassava roots are the most perishable of the major root crops and deteriorate in air at ambient temperature in a few days. In subsistence agriculture the plants are left in the ground until needed for food or for processing. The twin problems of perishability and the poisonous nature of the cyanogens present in cassava roots have been partly overcome by development of a large number of traditional forms of processing in different parts of the world. In East Africa cassava flour is preferred, whilst in West Africa a roasted product called garri is most commonly produced. In South and Central America there are many different cassava products.

In the South Pacific, where the introduced cassava varieties are virtually all sweet (low cyanide), the roots after peeling are boiled and eaten. In Eastern and Central Africa where cassava flour is made by sun drying and heap fermentation the retention of cyanide is about ten times that of garri and farinha. The situation is made much worse in drought years which are a normal feature of the climate, when water stress on the cassava plant causes a large increase of the cyanide content of the roots. We have developed a simple wetting method for removing cyanide from flour and have used this to control konzo in many villages in Democratic Republic of Cameroon (DRC).

Although studies in experimental animals have been inconsistent in reproducing this effect and may suggest that the primary effect is in aggravating existing conditions rather than inducing diabetes on its own, dietary exposure to linamarin has also been reported as a risk factor for developing glucose intolerance and diabetes (Yessoufou, 2002). Inspite of the few available report of the effects of linamarin on humans, critical research is needed to carry to scientifically ascertain various postulations made about cassava and linamarin. Hence, this present study is targeted at investigating the effects of linamarin from 419 bitter cassava on renal electrolytes of wistar rat's model in Nigeria.

2.0 Materials and Methods

2.1 Materials

Animals: Twenty-five (25) Wistar rats
419 species of bitter cassava roots and leaves
Linamarin (cassava juice)
Water
Animal feed
Chloroform
Syringe
Surgical gloves
Weighing balance
Cotton wool
Dissecting board
Dissecting blade
Beaker
Permanent marker
Local bottle
Slides

2.2 Methods

2.2.1 Experimental design

Twenty-five (25) Adult female wistar rats were provided by the University of Port Harcourt's Faculty of Basic Medical Science. The wistar rats were brought to the weighing scale to establish the exact weigh. The wistar rats weighed between 150 and 250 grams. Wistar rats were maintained in a cage for acclimatization for a week to adjust to their new surroundings. There were five groups of animals, and each group received water and rat feed as food. Five rats were in Group 1 (the control group), which were housed in faculty of basic medical sciences, college of Health Sciences, University of Port Harcourt animal house in a cage and given water and rat food to eat.

Group	No. of Animals	Mode of Treatment
Group 1 (Control) Animal feed plus Water	5 Rats	Orally
Group 2 (Bitter cassava konzo induced)	5 Rats	
Group 3 (4.7ml Linamarin (Cassava juice)	5 Rats	
Group 4 (2.3ml Linamarin induced group (cassava juice)	5Rats	
Group 5 (0.7ml linamarin induced group (cassava juice)	5Rats	

Five rats in group two were housed in a cage and given water and bitter cassava. Five rats in group

three were caged and given 4.7ml of linamarin (cassava juice) and water to induce them. Five rats in group four were caged and given a 2.3ml dosage of linamarin to induced them. Five rats in group five were caged together and given 0.7ml of linamarin to stimulate them. The whole study lasted for five weeks (35 days).

2.3 Ethical clearance

The University of Port Harcourt's Research Ethics Committee authorized the ethical clearance letter.

2.4 Sample size

The sample size for the experiment is determined by power method. The size of the study were twenty-five (25) female Wistar rats.

2.5 Plant collection and identification

The 419 species of bitter cassava roots and leaves were harvested from the Ministry of Agricultural Farm in Rumuodomaya Rivers State, Nigeria.

2.6 Processing of bitter Cassava root

Early in the morning, before the sun rise, fresh cassava roots were procured from the farm Ministry of Agricultural Farm in Rumuodomaya Rivers State, Nigeria. The brownish outer coating of the roots was completely peeled off, and the white inner layer was thinly sliced into flakes and put on a tray before being exposed to sunlight for a week. It was then administered to the test animals as bitter cassava feed after being bundled together and ground into a powder using a large motor machine.

3.0 Chemicals and Reagent

3.1 Processing of linamarin

The 419 specially grown cassava leaves from the Ministry of Agriculture's Rumuodomaya farm in Rivers State were brought to the University of Port Harcourt's Biomedical Laboratory of the School of Science Laboratory Technology. Fresh cassava leaves weighing roughly 70g were separated from the stem and placed in a glass mortar with 996.35 M HCI. A lab pistle was used to pound the mixture once it had been combined. After centrifuging the dark green colored solution, the clear supernatant liquid was collected using a Pasteur pipette. The linamaraze-containing solution was kept frozen in a deep freezer cabinet at 200°C. The frozen linamarin solution is stable for at least five months, according to experiments.

4.0 Laboratory Tests for Renal Function Parameters

The following laboratory tests were carried out:
Sodium (Maruna and Trider method) mmol/L was used for the analyses.

Principle: The present method is based on reaction of sodium with a selective chromogen producing a chromophore whose absorbance varies directly as the concentration of sodium in the test sample.

Procedure: The test tubes were labelled as standard, blank, and test.

- Pipette 10ml of the reagent into all test tubes.
- 0.0ml of the samples was added into appropriate tubes
- The samples were mixed and incubated for 5 mins at 25c
- The absorbance at 630nm was read and recorded.
- Potassium (Tiets N.W. method) unit mmol/L was used for this analysis.

Principle: The amount of potassium is determined by the use of sodium tetraphenylboron in a specifically prepared mixture to produce a colloidal suspension. The turbidity of which is proportional to potassium concentration in the sample.

Procedure: The test tubes were labelled as standard blank and test.

- Pipette 1ml of the reagent was released into all the tubes.
- 10ml of the sample was added into appropriate tubes.
- The samples were mixed and allowed for 3mins at 25c.
- Zero the spectrophotometer using blank at 500nm
- The absorbance was read and recorded.

Chloride: (Levinson S.S. Method) unit mmol/L was used.

Principle: The quantitative displacement of thiocyanate by chloride from mercuric thiocyanate any subsequent formation of a red ferric thiocyanate complexes is measure calorimetrically.

Procedure: The tubes were labelled as test, standard, and bank.

- Pipette 1.0ml of the reagent into the tubes.

- 10ul of the samples were added into the tubes appropriately.
- The samples were mixed and incubated for 5mins at 25c
- The absorbance at 480nm was read and recorded.
- Bicarbonate (HCO^3) (Back Titration Method)

Principle: Serum HCO^3 was reacted with excess standard HCl. The remaining HCl was back titrates with standard NaOH using phenol red as indicator.

Procedure: 50ml conical flask was added to a CO^2 – free d/w 250ul, 200ul sample, 0.0/NHCL 1mml, was well mixed and 3 drops of phenol red was added. The flask was whirl to release the CO^2.

The resultant solution with 0.0/N NaOH was titrated until the initial light yellow colour fades to a light purple at the end-point. The remaining NaOH that does not take part in the reaction was read. The reading obtained was divided by + wo: This gives the concentration of HCO_3 in the sample unit mmol/L. Creatinine (Direct End-Point Method) umol/L

Principle: Creatinine reacts with picric acid in alkaline solution to form a coloured complex. The amount of complex formed is directly proportional to the creatinine concentration.

Procedure: The tubes was labelled as test, standard and blank.

- Pipette 2.0ml of reagent, into all the tubes.
- 0.1ml of the sample, standard and d/w was added into the tubes respectively.
- The sample was mixed and after 30seconds, the absorbance of the standard and sample was read. Exactly 2mins later, the absorbance of the standard and sample was read. A_2 of standard and sample $A_1 – A_2 = A$

4.1 Statistical analysis

Data was analyzed using SPSS version 23.0. Data was handled both manually and electrically, analyzed data was presented with table. Mean comparison (descriptive analysis) was done with one way analysis of variance. Confidence unit of 95% group difference was considered significant at $P \leq 0.05$, the result are shown as mean $\pm$ standard error of mean.

Values were represented as meant SD in descriptive statistical analysis using the statistical program for the social sciences (SPSS IBM Version 23.0 and Microsoft Excel 2019 version. The significant difference between the groups was analyzed using one-way analysis of variance (ANOVA), and multiple controls were utilized as a control.

Figure 1: Wistar Rats were Colored to Differentiate the Various Groups

4.2 The result analysis

Effect of Linamarin on Renal Electrolyte parameters in konzo induced Wistar rats

Group	K	Na	CL	HNO_3	Urea	Creatinine
Control	3.25 ±0.05	122.50 ±1.50	97.50 ±1.50	26.00 ±1.00	4.20 ±0.20	86.00 ±4.00
Bitter Cassava	4.17 ±0.18	132.00 ±4.51*	87.67 ±5.78*	25.00 ±2.08	4.13 ±0.69	88.33 ±11.67
4.7 ml of linamarin	4.60 ±0.25*	143.67 ±6.89*#	83.67 ±3.38*	27.33 ±1.76	4.73 ±0.53	98.33 ±9.70*#
2.3 ml of linamarin	4.97 ±0.34*	149.00 ±7.02*#	95.67 ±2.40*#	27.33 ±1.45	4.93 ±0.24	100.00 ±4.04*#
0.7ml of linamarin	5.23 ±0.18*	157.67 ±2.60*#	84.67 ±5.69*	28.33 ±0.88	4.07 ±0.24	81.00 ±3.06

**Value is significant at p≤0.05 when compared to the control; #Value significant at p≤0.05 when compared to GP2 (Konzo induced group).*

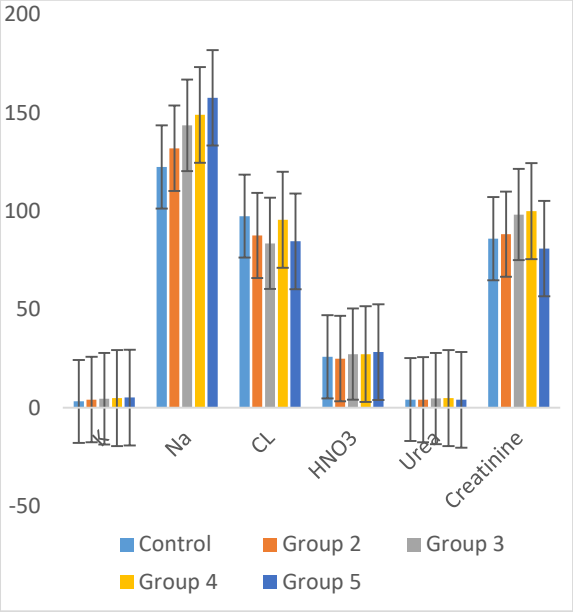
5.0 Discussion of Results

The results of the bitter cassava juice (Linamarin) effect of on renal indices in wistar rats for five (5) weeks, (thirty-five (35) days showed a statistical significant at p≤0.05 when Compared with

the control. Potassium showed significant increase across all the groups treated with bitter cassava induced-konzo and Linamarin compared to the control.

Hyperkalaemia is a condition in which the potassium levels in your blood get too high, too much potassium in your blood can damage your heart, make you feel palpitations and even cause a heart attack (Cleveland Clinic, 2023).

Figure 2: A Bar Chart Showing the Effect of Linamarin on Electrolyte Parameters in Konzo Induced Wistar Rats



Also revealed significant increase of sodium althrough the groups treated with bitter cassava induced-konzo and Linamarin compared with the control. In renal epithelial cells, a rise in sodium uptake across the apical membrane increases intracellular sodium concentration, which in turn stimulates the turnover rate of Na+-K+-ATPase and thereby enhances sodium efflux across the basolateral membrane, a condition called Hypernatremia (High Level of Sodium in the Blood) A prolonged increase in sodium (Hypernatremia) causes dramatic hypertrophy and hyperplasia and a rise in the quantity of Na+-K+-ATPase in the basolateral membrane. These structural and functional changes occur in the kidney in the absence of alterations in plasma aldosterone and vasopressin levels. B A Stanton and B Kaissling (1989).

The result is in agreement with Nehli et al (1994) and Armstrong.et al (2002) that stated that increase of sodium induces acute diuretic effect. It displayed a decrease in chloride, a prolonged decrease of chloride causes hypochloremia, a condition of an electrolyte imbalance that occurs when there's a low amount of chloride in the body. Metabolic alkalosis is directly associated with hypochloremia as sodium bicarbonate reabsorption in the proximal convoluted tubule increases in hypovolemic settings with increased levels of angiotensin II Akoum,et al ,2021. Also revealed an increase of bicarbonate although groups treated with linamarin except the group 2 treated with bitter cassava induced-konzo which has a decrease value. Metabolic alkalosis there is excess of bicarbonate in the body fluids. It can occur in a variety of conditions. It may be due to digestive issues, like repeated vomiting, that disrupt the blood's acid-base balance. It can also be due to complications of conditions affecting the heart, liver and kidneys (Cleveland Clinic, 2023). The result is in support with Nehli et al (1994).

The kidneys eliminate, among other products, urea, uric acid, and creatinine, in addition to metabolizing and eliminating drugs and toxins Baynes, et al 2006. Acute renal injury is characterized by increases in nitrogen waste products, such as urea nitrogen and creatinine, in addition to glucose, urea, creatinine, which are retained in the blood Papadakis, et al 2015 and which are indicators of glomerular filtration failure Sousa,et al, 2002 Canal, et al 2013, Gutiérrez-Vázquez, I.R. La , 2012. Therefore, a decrease in urinary volume causes an increase in the passive reabsorption of urea and a decrease in its elimination, which depends on protein intake and catabolism (Castaño-Bilbao et al, 2009).

This failure in the detoxification processes could have occurred in the present study, in which urea and creatinine, among the other biochemical parameters, were higher in the rats treated with linamarin and the toxic cassava juice dose, suggesting a decrease in glomerular filtration Haley, T.J.; Berndt, W.O, 1987. It is possible that failure in the elimination of potential toxic substances related to kidney and liver damage associated with cassava juice or linamarin consumption could contribute to Konzo disease and some neurological alteration as seen in this study. Statistically showed a significant increase Urea and

Creatinine levels in groups 3 and 4 and a significant decrease in groups 2 and 5. The increase observed in urea and creatinine indicates that kidney function would deteriorate as it prolongs which is in accordance with a study carried out by Nehli et al (1994). Hence, the finding of this study has further confirm the effects of bitter cassava induced-konzo and Linamarin on renal functions of using wistar rat's model.

6.0 Conclusion

In order to use plants that contain considerable amounts of linamarin in food such as cassava, they must first undergo extensive processing and detoxification. This is because linamarin and its methylated relative lotaustralin can degrade to the poisonous chemical hydrogen cyanide when exposed to enzymes and gut bacteria in the human intestine. The glucoside of ingested and absorbed linamarin is swiftly eliminated in the urine, and it doesn't seem to be acutely hazardous. In the low-land tropical regions, consumption of cassava products containing negligible amounts of linamarin is common. High levels of linamarin found in foods made from incompletely processed cassava roots have been linked to dietary toxicity, particularly with konzo, an upper motor neuron disease first identified in African populations by Trolli and later studied by Hans Rosling's research network. This study has been able to establish that cassava plant contains linamarin that cause some damages to the renal system.

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