Oral Administration of Palm wine Attenuates Acrylamide-induced toxicity in Wistar Rats

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ABSTRACT
Background to the study*: Roasted, fried and baked foods are commonly contaminated by a cellular toxicant called acrylamide. A greater number of people who consume these foods are usually unaware of the possible deleterious effects of this toxicant. The present study explored the effects of palm wine on acrylamide induced toxicity in male Wistar.*
Methodology*: The study involved 20 male wistar rats separated into 4 groups of 5 rats each as follows; Group 1 served as control. Animals in groups 2, 3 and 4 respectively received a daily oral dose of 30mg/kg of Acrylamide (ACR) throughout the experiment. Group 2 remained untreated (ACR only). Animals in groups 3 received in addition, 10ml/kg/day of palm wine while group 4 received 150mg/kg/day of vitamin E respectively. All treatments were given orally for 14 days and thereafter animals were sacrificed and blood samples collected to determine the concentrations of some liver markers (liver enzymes, albumin and total protein), renal markers (electrolytes, urea and creatinine) and oxidative stress markers (GSH, GPx, Catalase, SOD, and MDA) in the blood using standard methods.*
Results*: Our results showed that oral administration of palm wine caused significant reduction in the plasma levels of ALT, ALP, total protein and albumin but no significant change in AST. This signifies a possible hepato-protective potential of palm wine. For the markers of renal function, only the urea concentrations were significantly reduced. The sodium and potassium concentrations were significantly increased while creatinine, chloride and bicarbonate concentrations remained unchanged. There was a significant rise in catalase activity ($p < 0.05$), slight increases in GSH and GPx levels while the SOD and MDA concentrations were not changed in response to oral administration of palm wine.*
Conclusion*: Oral administration of palm wine caused significant reduction in the plasma levels of ALT, ALP, total protein and albumin and urea. Plasma level of catalase, sodium and potassium were significantly increased but no significant changes in AST, chloride, bicarbonate, GSH, SOD and MDA levels. Our study suggests that palm wine might have possible protective effects on the liver and kidneys probably due to its antioxidant potential.*

Key words: *Palm wine, Black pepper, Attenuates, Toxicity, Acrylamide, Wistar rats*

INTRODUCTION

Most junk foods and other widely accepted appetizing meals are products of either direct or higher thermal heating; example of which are roasted, fried, and baked foods (Alefe, 2024). Acrylamide is a toxicant commonly produced when carbohydrate-rich foods are refined at very high temperatures (Delgado *et al*, 2020; Lee and Kim, 2020) and also present in some industrial products. It is a water-soluble compound used to produce different chemicals and industrial applications at low cost including cosmetics, food processing, agriculture, and water purification (Radwan *et al*, 2023). The incidence of acrylamide in foods processed by higher

temperatures was first noted by the food administration agency in Sweden (SNFA) in 2002 (Ferrer-Aguirre *et al*, 2016). Since then, many researchers have reported the presence of the chemical in deeply baked and fried dishes (Rifai & Saleh, 2020; Pan *et al*., 2020; Timmermann *et al*, 2021 Lingnert et al., 2022) including; fried and roasted potatoes, vegetable-crisps, cocoa, bread, roasted coffee. Aside ingestion into the gastrointestinal tract, acrylamide can also gain entry into the body via the respiratory tract and the epithelium of the skin. Acrylamide is a toxicant which has been reported to induce toxicity many internal organs (liver, kidneys, nervous system, etc.) (Govindaraju *et al.*, 2024).

Palm wine is a traditional alcoholic drink produced from the fermented sap of palm trees. It has a characteristic sweet but slightly sour taste and commonly consumed in Sub-Saharan Africa and other part of the world. In Africa, palm wine is used to prepare some herbal medications and it is also popularly consumed during periods of festivities (Nwaiwu & Chikezie, 2020). Palm wine is a rich source of many bioactive compounds including carbohydrates, proteins and mineral elements such as potassium, iron, magnesium, sodium, copper, and zinc (Sarkar *et al,* 2023; Eze *et al,* 2019). It also contains polyphenols (including flavonoids and carotenoids) and also has immune-stimulatory properties (Robledo-Marquez *et al*, 2021). Other studies suggest that natural products are endowed with numerous bioactive compounds making them potentially beneficial to our health (Ajah *et al*., 2015; Obia *et al*., 2016; Obia *et al*., 2018; Chinko *et al*., 2023; Charles *et al*., 2024; Obia *et al*., 2024; Emmanuel *et al*., 2025; Obia & Emmanuel, 2025; Obia *et al*., 2025). The health benefits of palm wine would be evaluated on the basis of presence of these bioactive compounds.

In some cultures, thermally processed carbohydrate based foods such as fried yam and potatoes constitute a greater proportion of diets, thus increasing their risk of exposure to acrylamide toxicity (Rifai *et al*., 2020; Timmermann *et al*., 2021). These meals are often consumed together with palm wine. The aim of our study was to investigate the effect of palm wine on the acrylamide induced toxicity in male wistar rats.

MATERIALS AND METHODS

This study was carried out in the department of Human Physiology, Faculty of Basic Medical Sciences, Rivers State University with ethical approval number: RSU/FBMS/REC/24/104. The experiment involved 20 male wistar rats separated into 4 groups of 5 rats each which were acclimatized for a period of two weeks being provided with standard animal chow and water *ad libitum*. Acrylamide was procured from a chemical shop (Joechem ventures) while fresh palm wine was purchased from a palm wine tapper in Choba community. The groups include; Group 1 which served as control and received distilled water and animal chow throughout the period of the experiment. A daily oral dose of 30mg/kg of Acrylamide was respectively used to induce toxicity (Mahmood *et al*., 2015) in Groups 2, 3 and 4. Group 2 remained untreated (Acrylamide only). Group 3 received in addition, 10ml/kg/day of palm wine while Group 4 received in addition, 150mg/kg of vitamin E (Ebuehi *et al*., 2012).

All treatment were given orally for 14 days and thereafter animals were sacrificed and blood samples collected to determine the concentrations of oxidative stress markers, some liver biomarkers and renal parameters in the blood. All the parameters were determined using standard methods and values recorded.

Data were analyzed using SPSS vs 23 and presented in Tables. Continuous variables were expressed as mean ± SEM. The differences between each group were analyzed using paired sample t-test and ANOVA. Values of $p< 0.05$ were considered significant with a confidence level of 95%.

RESULTS

Table 1: Effects of oral administration of palm wine on some biomarkers of liver function in acrylamide-induced toxicity in male Wistar rats.

GROUP	**AST** (IU/l)	**ALT** (U/l)	**ALP** (U/l)	**Total protein** (g/l)	**Albumin** (g/l)
Control	32.60 ± 3.54	22.80 ± 2.94	26.40 ± 0.68	67.80 ± 1.46	43.60 ± 1.08
ACR Only	31.60 ± 7.67	31.20 ± 4.71	28.40 ± 0.68	70.00 ± 0.89	46.60 ± 0.66
ACR + Palm wine	27.80 ± 0.86	18.80 ± 1.16 *	24.80 ± 0.58*	63.60 ± 1.66*	42.00 ± 1.95*
ACR + Vitamin E	33.20 ± 0.74	19.00 ± 1.27*	26.80 ± 1.32	67.40 ± 1.60	43.20 ± 0.80*

Values are expressed as Mean ± SEM (n = 5);
* Significantly different when compared to ACR only.

Table 2: Effects of oral administration of palm wine on some biomarkers of liver function in acrylamide-induced toxicity in male Wistar rats.

Group	Urea (mmol/l)	Creatinine (mmol/l)	Potassium (mmol/l)	Sodium (mmol/l)	Chloride (mmol/l)	Bicarbonate (mmol/l)
Control	4.62 ± 0.49	94.80 ± 9.74	5.02 ± 0.36	143.60 ± 5.99	48.80 ± 2.20	23.20 ± 0.80
ACR Only	6.04 ± 1.03	106.20 ± 11.21	3.80 ± 0.20	127.60 ± 4.69	38.20 ± 1.28 [a]	27.60 ± 1.47 [a]
ACR + Palm wine	4.34 ± 0.09[b]	88.40 ± 1.89	5.94 ± 0.20 [b]	159.60 ± 3.57 [b]	39.60 ± 0.87 [a]	27.00 ± 1.00 [a]
ACR + Vitamin E	4.50 ± 0.70	93.40 ± 12.58	5.92 ± 0.23 [b]	158.20 ± 3.43 [b]	44.60 ± 3.44 [b]	26.00 ± 0.63

Values are expressed as Mean ± SEM (n = 5);
[a] significantly different when compared with control group (group 1)
[b] significantly different when compared with acrylamide treated group (group 2) ($p < 0.05$)

Table 3: Effects of oral administration of palm wine on oxidative stress markers of wistar rats treated with acrylamide.

Group	**GSH** (mg/dl)	**GPx** (U/l)	**CAT** (U/l)	**SOD** (U/l)	**MDA** ((mg/dl))
Control	2.28 ± 0.11	0.06 ± 0.00	3.90 ± 0.17	0.33 ± 0.02	0.48 ± 0.02
ACR Only	1.78 ± 0.05[a]	0.04 ± 0.00 [a]	2.06 ± 0.31[a]	0.26 ± 0.04	0.50 ± 0.02
ACR + Palm wine	2.04 ± 0.07	0.05 ± 0.00 [a]	3.47 ± 0.22 [b]	0.25 ± 0.03	0.50 ± 0.03
ACR + Vitamin E	2.18 ± 0.08 [b]	0.06 ± 0.00	3.79 ± 0.20 [b]	0.30 ± 0.04	0.49 ± 0.04

Values are expressed as Mean ± SEM (n = 5);
[a] Significantly different when compared to control (group 1)
[b] Significantly different when compared to acryl-amide treated group (group 2)
[c] Significantly different when compared to acryl-amide + vitamin E group (group 6) ($p < 0.05$)

DISCUSSION

Acrylamide (ACR) is a known organo-toxic agent which induces oxidative stress (Hajimohammadi *et al*., 2020; Wang et al., 2022) and causes hepatic and renal injuries (Belhadj *et al*., 2019; Ibrahim, 2024; Quasmi *et al*., 2025). In our study, oral administration of palm wine caused significant reduction in the serum concentrations of ALT, ALP, total protein and albumin compared to the ACR only group in a similar fashion as vitamin E. Administration of

vitamin E (a known antioxidant) ameliorated the toxic effects of acrylamide in the liver (Ebuehi *et al*, 2012; Refaat *et al*, 2020).

However, there was no significant change in the AST following palm wine administration. Our results on liver enzymes agrees with Haruna *et al*., 2020 who reported reduction in the serum concentration of these enzymes in apparently healthy rats following oral administration of palm wine. Reduction in the serum concentrations of these liver enzymes suggests improved liver health (Oyewo *et al*, 2017; Khan *et al*, 2021)

Palm wine also significantly reduced urea levels ($p < 0.05$) but caused a non-significant reduction in the creatinine concentration compared to the ACR only group suggestive of possible nephro-protective property. The basic function of the kidneys is to regulate fluid and electrolyte balance. The serum concentrations of sodium and potassium were significantly raised ($p < 0.05$) following administration of palm wine. However, the concentrations of chloride and bicarbonates remained unchanged. Studies have shown that palm wine is a rich source of electrolytes including potassium and sodium (Eze *et al*, 2019; Sarkar *et al*, 2023). The electrolyte composition of palm wine could be beneficial in conditions requiring fluid and electrolyte replacement.

The possible organo-protective potential of palm wine could be based on its antioxidant properties (Erukainure *et al*., 2019; Haruna *et al*., 2020). It contains phytochemicals including phenolics, vitamin C, flavonoids and carotenoids that have antioxidant potentials. The flavonoids in palm wine have been reported to prevent lipid-peroxidation (Kolota *et al*, 2020). Our study showed a significant increase in catalase ($p < 0.05$), slight increases in GSH and GPx levels while the SOD and MDA concentrations were not changed in response to oral administration of palm wine. Antioxidant enzymes act by inactivating oxidants and thus protects against cellular injury (Khan *et al*, 2011). This study thus highlights the potential beneficial effects of moderate consumption of palm wine.

CONCLUSION

Oral administration of palm wine caused significant reduction in the plasma levels of ALT, ALP, total protein and albumin and urea. Plasma level of catalase, sodium and potassium were significantly increased but no significant changes in AST, chloride, bicarbonate, GSH, SOD and MDA levels. Our study suggests that palm wine might have possible protective effects on the liver and kidneys probably due to its antioxidant potential.

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