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Phytochemical Composition, Antioxidant Potential, and Radiological Risk of Sachet Herbal Alcoholic Drinks in Ughelli, Nigeria

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ABSTRACT

Sachet herbal alcoholic drinks are widely consumed in Ughelli, Nigeria, yet their phytochemical composition and antioxidant potential remain poorly characterized. This study investigated twenty commonly consumed sachet herbal alcoholic drinks using qualitative and quantitative phytochemical screening alongside in-vitro antioxidant assays. Results revealed that terpenes and glycosides were the most frequently detected phytochemicals, while saponins and steroids were absent. Alkaloids, tannins, and flavonoids were present in varying concentrations, with samples I, J, S, and T exhibiting higher levels of phenols (up to 0.145 mg/ml) and flavonoids (up to 0.347 mg/ml). Antioxidant assays demonstrated strong correlations between phenolic and flavonoid content and antioxidant activity, with samples I, S, and T showing the highest reducing power, and samples G and Q achieving the greatest DPPH radical scavenging activity (88.06%). Despite evidence of bioactive compounds and antioxidant potential, significant variability among brands highlights the lack of standardization and regulatory oversight. These findings provide baseline scientific data on sachet herbal alcoholic drinks in Ughelli and underscore the need for stricter quality control and toxicological evaluation to ensure consumer safety.

Keywords:
Phytochemicals,
Antioxidant activity,
Herbal alcoholic drinks,
Terpenes,
Flavonoids,
Glycosides,
Public health.

INTRODUCTION

Herbal alcoholic drinks packaged in sachets are widely consumed in Nigeria, particularly in semi-urban and rural communities. They are marketed as remedies for ailments such as fatigue, sexual dysfunction, malaria, digestive disorders, and general body weakness (Okediji et al., 2023). In Ughelli town, Delta State, sachet herbal alcoholic drinks are readily available and heavily patronized due to cultural acceptance, aggressive marketing, and the perception that herbal products are inherently safe.

Phytochemicals such as alkaloids, flavonoids, tannins, phenols, and glycosides are naturally occurring bioactive compounds with diverse pharmacological properties, including antioxidant, anti-inflammatory, antimicrobial, and anticancer activities (Nwozo et al., 2023; Lila, 2005). While beneficial at appropriate levels, excessive intake especially when combined with high alcohol content may pose health risks. Alcohol enhances the solubility and bioavailability of phytochemicals, which may amplify both beneficial and adverse effects (Ashawani et al., 2023). Despite their widespread consumption, sachet herbal alcoholic drinks are often produced under poorly regulated conditions, with limited quality control, standardization, or labeling of ingredients (Dhama et al., 2015). Variations in plant species, preparation techniques, alcohol concentration, and storage conditions can result in significant differences in phytochemical content.

This study therefore investigates the phytochemical composition and antioxidant potential of sachet herbal alcoholic drinks consumed in Ughelli town, Delta State, Nigeria. The findings aim to provide baseline scientific data to guide regulatory oversight and public health awareness of these products and contribute to informed decisions on their safety, efficacy and regulation.

MATERIALS AND METHODS

Sample Collection

Twenty (20) sachet herbal alcoholic drink samples were selected based on popularity and availability in Ughelli town, Delta State, Nigeria. Each sample was collected in 1 L Marinelli beakers to ensure uniformity and prevent contamination. The drinks were anonymized using codes

(A–T) to maintain ethical reporting standards (Okediji et al., 2023). Samples were stored at 4°C until analysis to preserve phytochemical integrity (Dhama et al., 2015).

Chemicals and Reagents

All chemicals and reagents used were of analytical grade. The solvents; ethanol and methanol were employed for phytochemical extraction due to their efficiency in dissolving plant secondary metabolites (Ashawani et al., 2023). While the reagents for phytochemical screening are as follows:

i. Mayer's, Wagner's, and Dragendorff's reagents for alkaloids (Raal et al, 2020)
ii. Ferric chloride for phenols and tannins (Siddiqui et al., 2017)
iii. Lead acetate and sodium hydroxide for flavonoids (Horowitz, 2003)
iv. Salkowski's reagent for terpenoids (Edo et al., 2023)
v. Foam test reagents for saponins (Bottcher et al, 2016)
vi. Keller-Killiani reagent for glycosides (Kabir et al, 2026)

Qualitative Phytochemical Screening

Standard phytochemical screening methods were employed to identify the presence or absence of specific phytochemicals (Raal et Al.,2020; Siddiqui et al., 2017):

i. Alkaloids: Precipitation reactions with Mayer's and Dragendorff's reagents.
ii. Tannins: Color change (brownish-green or blue-black) upon addition of ferric chloride.
iii. Phlobatannins: Red precipitate formation after boiling with hydrochloric acid.
iv. Saponins: Froth formation and emulsion stability after mixing with olive oil.
v. Steroids: Color change (violet to blue/green) after reaction with acetic anhydride and sulfuric acid.
vi. Terpenoids: Reddish-brown coloration at the interface in Salkowski's test.
vii. Glycosides: Brown ring formation in Keller-Killiani test.
viii. Flavonoids: Yellow-green coloration after reaction with dilute ammonia.

Quantitative Phytochemical Analysis

Quantitative assays were performed to determine the concentration of key phytochemicals:

i. Phenolic content: Measured using Folin-Ciocalteu reagent, expressed as milligrams of gallic acid equivalents (GAE) (Genwali et al., 2013).
ii. Flavonoid content: Determined using aluminum chloride colorimetric method, expressed as milligrams of quercetin equivalents (Mammen et al. 2012).
iii. Tannins: Measured using Folin-Ciocalteu method, expressed as milligrams of tannic acid equivalents (Martins et al,. 2021).
iv. Alkaloids: Estimated using colorimetric methods (Bottcher et al,. 2016).

Absorbance readings were taken using a UV-Vis spectrophotometer at specific wavelengths (760 nm for phenols, 415 nm for flavonoids, 725 nm for tannins). Triplicate measurements were performed to ensure reproducibility.

Antioxidant Assays

Four complementary assays were conducted to evaluate antioxidant potential:

i. Reducing Power Assay: Measured electron-donating ability by reduction of Fe^{3+} to Fe^{2+} (Edholm et al,. 2000). Absorbance was read at 700 nm.
ii. Total Antioxidant Capacity (Phosphomolybdenum Method): Assessed cumulative antioxidant activity via reduction of Mo(VI) to Mo(V) (Prieto et al., 1999). Absorbance was measured at 695 nm.
iii. Nitric Oxide (NO) Inhibition Assay: Evaluated the ability of samples to scavenge nitric oxide radicals generated from sodium nitroprusside (Jagetia et al,. 2004). Absorbance was read at 546 nm.
iv. DPPH Radical Scavenging Assay: Determined free radical scavenging activity using 1,1-diphenyl-2-picrylhydrazyl (DPPH). Results were expressed as percentage inhibition and IC_{50} values (Adebiyi et al., 2017).

Positive controls (ascorbic acid, gallic acid, and quercetin) were included to validate assay performance, while acetone served as a negative control.

The radical scavenging activity was determined as the percentage of inhibition using the following equation (Adebiyi *et al, 2017*)

$$\% \text{ scavenging activity} = \frac{A_{control} - A_{test}}{A_{control}} \times 100 \qquad (1)$$

where:

$A_{control}$ -the absorbance of the control (DPPH solution without any sample)

A_{test} - the absorbance of the test sample (DPPH solution plus the sample).

The inhibitory concentration (IC50) value is the concentration of the sample that is required to scavenge 50% of the DPPH free radicals.

RESULTS AND DISCUSSION

Table 1 gives the qualitative phytochemical composition in the study samples. Terpenes and glycosides were the most frequently detected compounds. Alkaloids, tannins, and flavonoids were present in moderate concentrations, with samples I, J, S, and T showing the highest levels. Saponins and steroids were absent.

Table 1: Qualitative analysis of phytochemicals in samples of sachet herbal alcoholic drinks

Sample	Saponins	Phenol	Tannin	Flavonoid	Alkaloid	Terpenes	Steroids	Glycosides	Phlobatannin
A	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	+	-	+	-
C	-	-	-	-	-	+	-	+	-
D	-	-	-	-	-	-	-	-	-
E	-	--	-	-	-	+	-	+	-
F	-	-	-	-	-	+	-	+	-
G	-	-	+	+	+	+	-	+	+
H	-	-	-	-	-	+	-	+	-
I	-	-	+	+	+	+	-	+	+
J	-	-	+	+	+	+	-	+	+
K	-	-	-	-	-	+	-	+	-
L	-	-	-	-	-	+	-	+	-
M	-	-	-	-	-	+	-	+	-
N	-	-	-	-	+	+	-	-	-
O	-	-	+	-	+	+	-	+	-
P	-	-	-	-	-	+	-	+	-
Q	-	-	+	+	+	+	-	+	+
R	-	-	-	-	-	+	-	+	-
S	-	-	+	+	+	+	-	+	+
T	-	-	+	+	+	+	-	+	+

+ = Present and - = absent

Quantitative analysis of the phytochemicals in the samples as shown in Table 2 revealed that phenol concentration ranged from 0.026 mg/ml (Sample A) to 0.145 mg/ml (Samples G and Q). Flavonoid concentration varied widely, with the lowest being 0.020 mg/ml in Sample D and the highest at 0.347 mg/ml in Sample T. Alkaloid levels ranged from 0.003 mg/ml (Sample D) to 0.203 mg/ml (Sample I).

Table 2: Concentration of phytochemicals in samples of sachet herbal alcoholic drinks

Sample	Phenol (mg/ml)	Tannins (mg/ml)	Flavonoids (mg/ml)	Alkaloids (mg/ml)
A	0.026 ±0.004	0.021±0.002	0.031 ±0.002	0.107 ± 0.028
B	0.110 ±0.004	0.114±0.011	0.070 ±0.001	0.060 ±0.024
C	0.122 ±0.016	0.126±0.002	0.037 ±0.002	0.046 ±0.019
D	0.060 ±0.007	0.058±0.003	0.020 ±0.002	0.003 ±0.003
E	0.082 ±0.039	0.069±0.002	0.031 ±0.001	0.022 ±0.002
F	0.114 ±0.017	0.114 ±0.004	0.065 ±0.002	0.035 ±0.035
G	0.145 ±0.020	0.151±0.005	0.144 ±0.002	0.020 ±0.010
H	0.128 ±0.018	0.133±0.004	0.103 ±0.003	0.109 ±0.050
I	0.144 ±0.021	0.149±0.006	0.322 ±0.009	0.203 ±0.044
J	0.143 ±0.022	0.150±0.005	0.347 ±0.027	0.040 ±0.015
K	0.134 ±0.022	0.141±0.002	0.142 ±0.011	0.109 ±0.050
L	0.076 ±0.007	0.077±0.001	0.022 ±0.005	0.008 ±0.010
M	0.118 ±0.012	0.125±0.002	0.075 ±0.004	0.057 ±0.057
N	0.124 ±0.015	0.125±0.002	0.082 ±0.005	0.099 ±0.118
O	0.133 ±0.020	0.137±0.001	0.093 ±0.002	0.118 ±0.050
P	0.114 ±0.017	0.069±0.002	0.065 ±0.002	0.035 ±0.035
Q	0.145 ±0.020	0.114 ±0.004	0.144 ±0.002	0.020 ±0.010
R	0.128 ±0.018	0.151±0.005	0.103 ±0.003	0.109 ±0.050
S	0.144 ±0.021	0.133±0.004	0.322 ±0.009	0.203 ±0.044
T	0.143 ±0.022	0.149±0.006	0.347 ±0.027	0.040 ±0.015

The antioxidant activity in the studied samples are displayed in Table 3. Samples I, S, and T exhibited the strongest reducing power, while samples G and Q showed the highest DPPH radical scavenging activity (88.06%). A positive correlation ($p < 0.05$) was observed between phenolic/flavonoid content and antioxidant activity.

Table 3: In-vitro antioxidant properties of samples of sachet herbal alcoholic drinks

Sample	Reducing power 700nm	TOAC 695nm	Nitric oxide %inhibitio	DPPH %inhibition
A	0.047 ±0.009	0.162±0.017	48.24 ±2.84	41.25 ±2.45
B	0.740±0.030	0.973±0.197	43.58 ±1.73	66.42±0.80
C	0.860 ±0.051	4.058±0.296	53.64 ±1.38	77.98 ±1.93
D	0.422±0.014	1.007±0.108	48.82 ± 3.22	57.20 ±1.09
E	0.553 ±0.017	1.322±0.168	50.75 ±2.25	59.14 ±1.61
F	0.722 ±0.087	0.588 ±0.033	42.22 ±1.90	64.81 ±0.39
G	1.730 ±0.231	0.716±0.001	39.57 ±1.26	88.06 ±0.30
H	1.114 ±0.092	3.815 ±0.462	43.16 ±2.45	66.93 ±0.57
I	2.165 ±0.122	0.386±0.068	37.49 ±1.08	80.34 ±1.28
J	2.137 ±0.070	0.308±0.004	36.06 ±1.52	80.99 ±2.67
K	1.339 ±0.318	3.412±0.041	41.51 ±4.61	71.98 ±0.56
L	0.577 ±0.019	3.387±0.174	48.03 ±3.01	55.51 ±6.88
M	0.829 ±0.016	0.840±0.153	42.98 ±2.06	57.93 ±4.67
N	1.077 ±0.111	0.747±0.032	41.08 ±0.97	76.83 ±1.42
O	1.243 ±0.048	0.720±0.026	47.74 ±6.17	75.08 ±4.29
P	0.722 ±0.087	0.588 ±0.033	42.22 ±1.90	64.81 ±0.39
Q	1.730 ±0.231	0.716±0.001	39.57 ±1.26	88.06 ±0.30
R	1.114 ±0.092	3.815 ±0.462	43.16 ±2.45	66.93 ±0.57
S	2.165 ±0.122	0.386±0.068	37.49 ±1.08	80.34 ±1.28
T	2.137 ±0.070	0.308±0.004	36.06 ±1.52	80.99 ±2.67

Discussion

From Table 1, the qualitative analysis of the sachet herbal alcoholic drink samples revealed a selective distribution of phytochemical constituents. Overall, terpenes and glycosides were the most frequently detected compounds, whereas saponins, phenols, and flavonoids were largely absent. Terpenes were identified in most samples (B, C, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, and T), suggesting that these secondary metabolites are common among the studied drinks. Terpenes are known for their aromatic qualities and potential therapeutic benefits, including antimicrobial and anti-inflammatory activities (Edo et al., 2023). Glycosides were also widely present, particularly in samples B, C, E, F, G, H, I, J, K, L, M, O, P, Q, R, S, and T. Glycosides are important due to their cardiotonic and antioxidant effects. Alkaloids were detected in fewer samples but were notably present in G, I, J, N, O, Q, S, and T. Alkaloids have diverse biological activities, including analgesic and stimulant effects, making their presence significant for the pharmacological potential of these drinks. Tannins and flavonoids were moderately detected in samples G, I, J, Q, S, and T. The occurrence of these phytochemicals may be associated with herbal ingredients blended in bitters, which are known for strong antioxidant and antimicrobial activities, and contribute to the health claims often associated with herbal beverages (Fantasma et al., 2024). Saponins, phenols, steroids, and phlobatannins were either absent or sparsely distributed. No samples showed positive reactions for saponins or steroids, while phlobatannins were detected only in a few samples (G, I, J, Q, and S). In summary, the herbal alcoholic drinks exhibited a rich diversity of terpenes, glycosides, and alkaloids, while other phytochemicals such as saponins and phenols were notably absent. The presence of these active constituents suggests potential health-promoting properties but also highlights variability among different brands and formulations.

Table 2 shows considerable variability in phytochemical concentrations across the 20 samples (A–T). Phenol concentration ranged from 0.026 mg/ml (Sample A) to 0.145 mg/ml (Samples G and Q). Samples with high phenol content (G, Q, I, J, and S) are likely to possess stronger antioxidant potential, given the well-documented free radical scavenging activity of phenolic compounds. In contrast, the low phenol content in Sample A suggests a weaker antioxidant base. Tannin concentrations ranged from 0.021 mg/ml in Sample A to 0.151 mg/ml in Samples G and R. Tannins contribute to antioxidant and antimicrobial effects by precipitating proteins and scavenging free radicals, with Samples G, R, I, and J showing relatively high levels, indicative of strong biological activity (Hyeon-ju et al., 2015). Flavonoid concentration varied widely, from 0.020 mg/ml in Sample D to 0.347 mg/ml in Sample T. Flavonoids are powerful antioxidants due to their ability to donate hydrogen atoms or electrons. The highest concentrations, observed in Samples I, J, and T, aligned with their strong antioxidant values in DPPH assays (Wang et al., 2024). Alkaloid levels ranged from 0.003 mg/ml in Sample D to 0.203 mg/ml in Sample I. Alkaloids are known for pharmacological effects such as

anti-inflammatory and antioxidant actions, with Sample I's high alkaloid content reinforcing its phytochemical richness (Bhambhani et al., 2021).

Table 3 summarizes the in-vitro antioxidant activities using four assays: Reducing Power, Total Antioxidant Capacity (TOAC), Nitric Oxide Inhibition, and DPPH Radical Scavenging. Reducing Power ranged from 0.047 in Sample A to 2.165 in Samples I and S. Samples I, S, and T had the highest reducing power, correlating with their high phenol and flavonoid content. Samples with higher phenolic content, such as I, G, and T, demonstrated enhanced reducing power, consistent with literature on antioxidant mechanisms (Alam et al., 2023). Thus, samples rich in phenolic compounds exhibit strong electron-donating capacity, a hallmark of effective antioxidants (Chiorcea-Paquim et al., 2020). TOAC values were highest in Samples C (4.058), H (3.815), K (3.412), and R (3.815). Some of these samples, such as C and H, also showed elevated phenol and tannin content, suggesting strong cumulative antioxidant activity. Samples H and R, both rich in tannins, exhibited high TOAC values, reinforcing the role of tannins in total antioxidant capacity (Zg et al., 2020). Nitric Oxide Inhibition values ranged from 36.06% in Sample T to 53.64% in Sample C. Although Sample T had the highest flavonoid content, its relatively low nitric oxide inhibition may indicate a different mechanism or limited activity against nitric oxide radicals.

DPPH inhibition ranged from 41.25% in Sample A to 88.06% in Samples G and Q. High DPPH inhibition indicates effective hydrogen-donating ability and radical scavenging capacity, often attributed to phenolic compounds and flavonoids (Baliyan et al., 2022). Notably, Samples G and Q also had high phenol and flavonoid content, reinforcing this correlation. There was a strong alignment between high flavonoid levels and DPPH activity, particularly in Samples I, J, T, G, and Q. Sample I, with the highest alkaloid content, showed excellent performance across all antioxidant assays, although other alkaloid-rich samples did not consistently reflect the same trend. This suggests that alkaloids may contribute synergistically rather than independently to antioxidant potential.

CONCLUSION

Sachet herbal alcoholic drinks consumed in Ughelli contain diverse phytochemicals, with terpenes, glycosides, flavonoids, tannins, and alkaloids being the most prominent. These compounds contribute to antioxidant potential, but variability among brands highlights the need for stricter regulation. While these drinks may possess bioactive benefits, comprehensive quality control and toxicological evaluation are essential to safeguard consumer health.

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