World Journal of Applied Chemistry
2026, Vol. 11, No. 2, pp. 46–58
https://doi.org/10.11648/j.wjac.20261102.13

SciencePG
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Research Article

Phytochemical Identification and Assessment of Informal Psychoactives in Illicit Mixtures Used Among Youth Cohorts in Lagos State, Nigeria

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Abstract

The Non-conventional psychoactive mixtures are consumed indiscriminately, causes behavioral risks and criminal outcomes is linked to violence, aggression, impaired decision-making, and criminal activity for certain groups like area boys, street gangs in Lagos State. These substances frequently bypass the conventional regulatory systems, and are driven by poverty, social influence, and functional needs. Health impacts of users are severe but remain under-researched. The aim of this study is to identify and assess the psychoactive compounds as the possible agents responsible for psychoactive activity among youth in Lagos State, Nigeria. Material and methods: The experimental of this study involves dissolution and extraction method in aqueous and ethanol medium. The analytical techniques used for this study was gas chromatography-mass spectrometry (GC-MS). Results: The phytochemical results revealed that the ethanol extracts of natural plant samples alkaloid concentrations ranged approximately from 31.23 mg/100 g - 50.68 mg/100 g, while the aqueous extracts recorded values ranging from 23.01 mg/100 g - 52.48 mg/100 g. This study reveals that Lagos youths increasingly consume non-classical psychoactive substances notably concoctions and synthetic opioids that are informally produced, packaged, and consumed. In conclusion: The high presence of alkaloids, saponins, phenols and flavonoids are particularly significant because they are well known for their psychoactive properties.

Keywords

Psychoactive Compounds, Extraction, GC-MS, Synthetic, Mixture

1. Introduction

Abuse of non-conventional mixtures has been one of the most serious humans' problems and one of the most complex phenomena undermining the foundation of human society. The increasing prevalence of illicit substances and their mixtures in seized materials poses significant challenges for forensic analysis and law enforcement [1, 2]. The non-conventional mixture is consumed with little knowledge of their

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Received: 3 April 2026; **Accepted:** 20 April 2026; **Published:** 27 June 2026

chemical composition or health effects, making them particularly dangerous with associated serious mental health consequences, including psychosis, seizures, and, in some cases, death [3-5]. Non-conventional substances usually consumed among youths can be synthetic or natural are sometimes locally referred to as "*Colorado*," codeine-based cough syrups and tramadol-infused energy drinks, they have been classified as controlled substances, narcotic opioids, or restricted prescription drugs due to their high potential for addiction, abuse, and severe health [6-9]. Non-conventional mixtures are family of synthetically derived compounds designed to mimic the effects of other illicit substances, either pure or in prepared mixtures, that poses a similar public health concern as controlled substances but themselves are not under current legislation [10, 11]. The term "non-conventional" directly refers to the availability, novelty and affordability for abuse and misuse [12]. Wada *et al.,* [13], Igben et al., [14] and Olley [15] reported, that most of the young adults are drawn to consumption of these illicit mixtures because its accessibility, affordability and ability to evade legal detection but often carry far more severe health risks including seizures, psychosis, and fatalities [15-18]. In Nigeria, and particularly in urban cities such as Lagos, there is an alarming rise in the use of these non-conventional substances, (concoctions) and other unnamed mixtures often contain dangerous combinations of local gin or cocktail of codeine, tramadol, cannabis derivatives, household items such as bleach or soda and even nitrous oxide are consumed recreationally in clubs and homes [19, 20]. In Lagos Metropolis, youths are easily drawn to substances (suspected to be Psychoactive mixtures) due to various factors such as peer pressure, stress, curiosity, desire to feel high, poverty, social influence and functional needs [21-23].

Non-conventional mixtures often offer short-term euphoric, stimulating or hallucinogenic effects, making them desirable to youths seeking pleasure, experimentation or heightened performances [21-23]. The Nigerian youths increasingly consume non-conventional substances, notably concoctions and synthetic opioids that are informally produced, packaged, and consumed [24, 25]. The United Nations Office on Drugs and Crime (UNODC) reported that at the end of year 2023, over 1,200 unique New Psychoactive Substance had been identified globally, with approximately 75-100 new compounds emerging annually [10, 26].

Despite strict control of illicit substances and mixtures worldwide, a great diversity in the type and number of mixtures and concocted substances are on the increase which are emerging substances and not regulated usually found in the recreational and drug market in the attempt of manufacturers to evade drug legislation [27, 28]. Health impacts are severe, yet remain under-researched [20, 29]. However, chemical composition of most of these substances with multiple active compounds (adulterated or combined) are not well documented and regulated, reliable analytical methods for detection, identification, and quantification of these substances is urgently required [1, 30-33].

In Nigeria, and particularly in urban cities such as Lagos, there is an alarming rise in the use of these non-conventional substances, (concoctions) and other unnamed mixtures often contain dangerous combinations of local gin or cocktail of codeine, tramadol, cannabis derivatives, household items such as bleach or soda and even nitrous oxide are consumed recreationally in clubs and homes [34, 35]. In Lagos Metropolis, youths are easily drawn to substances (suspected to be Psychoactive mixtures) due to various factors such as peer pressure, stress, curiosity, desire to feel high, poverty, social influence and functional needs [21, 36]. Non-conventional mixtures often offer short-term euphoric, stimulating or hallucinogenic effects, making them desirable to youths seeking pleasure, experimentation or heightened performances [6, 37, 38]. The Nigerian youths increasingly consume non-conventional substances, notably concoctions and synthetic opioids that are informally produced, packaged, and consumed [39-43]. The United Nations Office on Drugs and Crime (UNODC) reported that at the end of year 2023, over 1,200 unique New Psychoactive Substance had been identified globally, with approximately 75-100 new compounds emerging annually [10, 44, 45]. Non-conventional mixtures and illicit substances chemically represent a category of synthetic or semi-synthetic substances created by modifying the chemical structure of well-known drugs. They include a wide range of substances, such as synthetic cannabinoids, synthetic cathinones (commonly known as "bath salts"), hallucinogens and stimulants [1, 46, 47]. NPS are associated with distinct ways of consumption, including smoking, snorting, swallowing, or injecting. Some can be sold as powders, pills, or liquids (synthetic cathinones), while others are infused on plant material, resembling traditional herbal products (synthetic cannabinoids). Non-conventional Substances are developed and extensively misused and abused for their euphoric effects as legal alternatives to conventional illicit psychoactive substances [48, 49].

Associated Homemade Mixtures: Patterns and Risks

A growing body of evidence highlights dangerous homemade concoctions usually consumed among Nigerian youths. Dumbili et al., [6], Emmanuel et al., [19], and Sharma *et al.* [50] reported, different homemade mixtures taken be university students in South -West Nigeria, 47% of respondents (university of Lagos students) consume cocktail of dried pawpaw leaf to heighten performances [51]. The study found that participants consumed a drink, cocktails labelled, "Gutter-Water", a mix of opioids (tramadol, codeine), cannabis and alcohol intended for potent effects. "Monkey-Tail", a homemade gin blended with cannabis parts, combining sedative and euphoric effects or a mixture of sodium hypochlorite solution (bleach), and novel beverage combinations like carbonated soft drinks mixed with candies [51]. Other ingestible items include candy-soft drink mixes such as "La Casera Apple Drink" with "Tom-Tom", used to elicit a mild high [6, 52, 53]. Other non-conventional items include the ingestion of bleach with soda,

10-day-old human urine, or lizard dung; inhalation of hydrogen sulfide (sewer gas) or nail polish and other toxic substances. These substances are seldom captured in formal surveys due to their informal nature, making them especially hard to regulate [6]. These practices reflect desperation, experimentation, and creative, but dangerous attempts at intoxication, often bypassing canonical pathways of drug use, with profound health risks [54].

2. Materials and Methods

2.1. Study Area

These are the study area maps where samples were collected for processing and analysis.

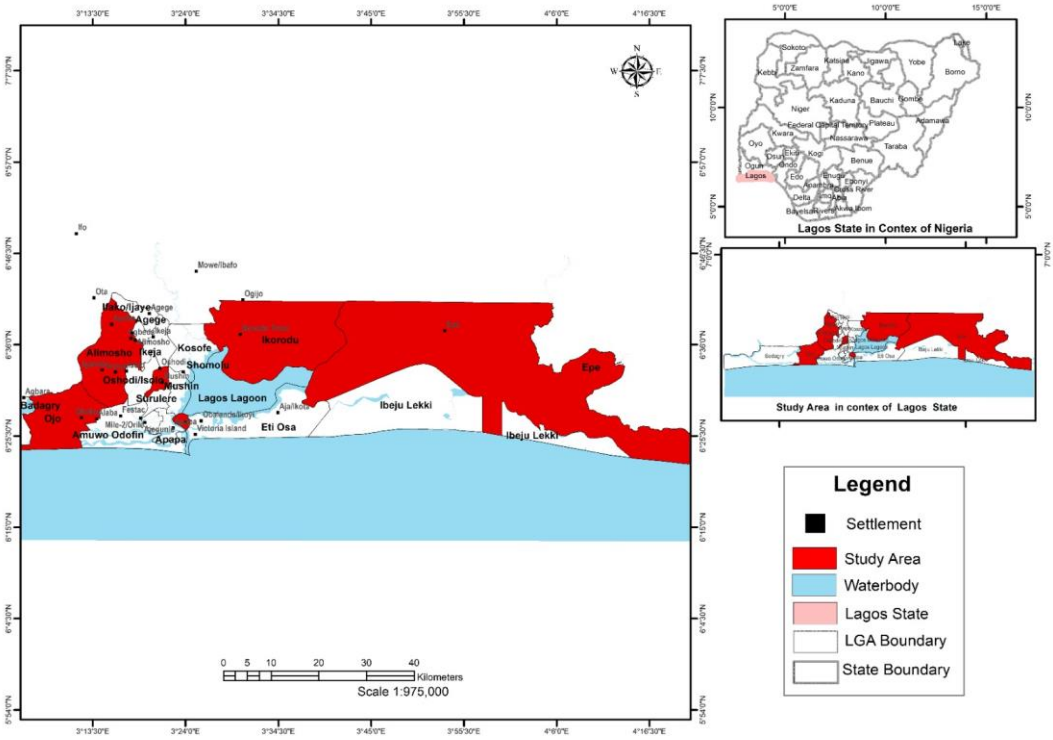

Figure 1. Map of Sampling points within the study Area. Source (GIS Lab).

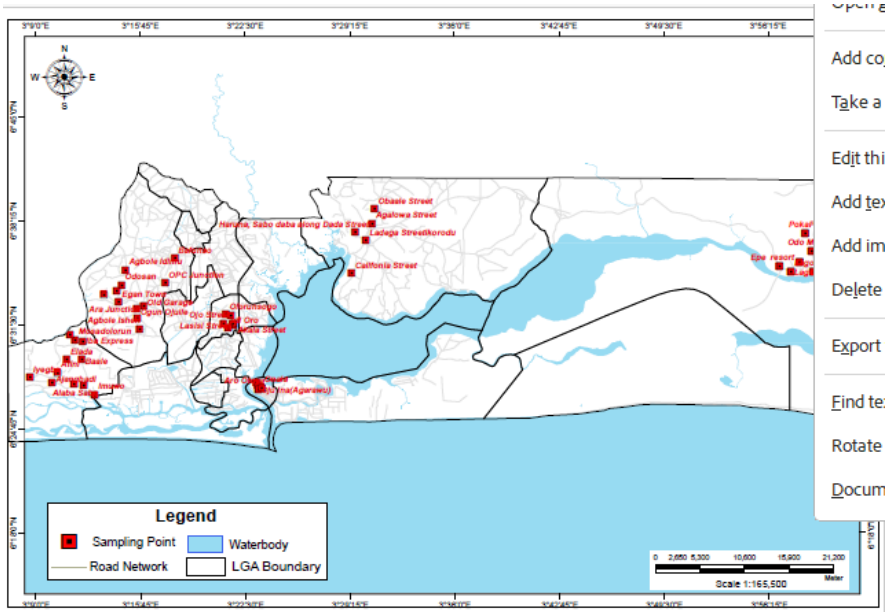

Figure 2. Map of study Areas (GIS Lab).

Table 1. Geographical coordinates of the sampling Areas.

Location	Longitude	Latitude
L1	6.45909193900	3.38825133000
L2	6.56214790100	3.23678440100
L3	6.58027236000	3.48913271400
L4	6.58155193600	3.98527942700
L5	6.52170893700	3.35632155300

2.2. Materials

2.2.1. Sampling and Sample Collection

The Samples collected for this study are bottled herbal beverages, fresh leaves, roots and stem of plants, cocktail homemade mixtures, dried blended plant matrixes wrapped in polythene nylon, pill package prescribed like- capsule, weed-like substances wrapped and packaged in papers (Table 1). Grab samples were collected from five educational regions (Mushin, Ikorodu, Epe, Ikeja and Ojo) coded and labelled in amber bottle (free from light interaction). The samples were composite to 14 similar different samples and were recorded according to its street names in the log book, no pre-determined sample size collected. Also, samples were identified and labelled and methods of preparation and consumption recorded in the log book.

2.2.2. Equipment, Reagents and Chemicals

All glassware and equipment were prepared and cleaned. The apparatus includes, amber glass bottles, Standard volumetric flasks, measuring cylinder, Rotatory evaporator, separating funnel, titrating set, pH meter. Evaporating dish, Steam bath, Desiccator, Regulated electric drying Oven, Analytical balance, conductometer/TDS meter.

All reagents and chemicals were analytical grade and used without further purification. Analytical grade methanol (99.8%), HPLC-grade acetic acid (99.7%), Acetonitrile, Ammonia solution, hexane, isopropanol, potassium phosphate, dichloromethane, ethanol, methylene chloride, ultrapure MilliPore water, Sodium hydroxide, Bromophenol blue indicator, Ammonium Chloride buffer, Eriochrome black T indicator and Standardized E. D. T. A, silver nitrate. Potassium chromate, Silver nitrate, Ammonium Molybdate, Hydrochloric acid, Phenolphthalein indicator, Nitric acid, Quinol, Sodium acetate, Dithizone solution (a), Dithizone solution (b) Potassium tartrate solution, Hydroxyl ammonium chloride solution, NaOH – KCN solution, tartaric acid solution, Methyl orange indicator, Chloroform, Nessler reagent, Zinc sulphate, Barium chloride, Potassium iodide, Sodium thiosulphate, Starch solution, Nitrate stock solution, Sodium chloride, H_2SO_4 solution, Bruline sulfanilic acid.

2.2.3. Sample Preparation and Extraction

G10 g each of the samples was pulverized, weighed and poured in to a stoppered amber bottle, defatted with 50 mL of hexane and then soaked in 250 mL of ethanol and 250 mL of water separately. This was then placed in a cupboard and allowed to stand for 72 hrs. The mixture was strained, pressed and filter using Whatman filter paper No 42 (125 mm). This process was repeated twice on the residue and the extract combined. The extracts were concentrated under reduced pressure at 80°C using a rotary evaporator and kept in a fume cupboard and dried. Crude extracts were shaken using separating funnel acidified to pH 2 with drops 0.01 M hydrochloric acid followed by 20 mL of dichloromethane. Prior to the analysis to the aqueous phase was then shaken with 0.01 M of sodium carbonate basified to pH 9 [5, 55-58].

3. Results

3.1. Phytochemical Analysis

3.1.1. Qualitative Analysis of Bioactive Compounds

Preliminary phytochemical screening of crude ethanolic extracts and aqueous extracts obtained was used as per standard procedure described by Harbone, [59] and Ejikeme *et al.,* [60], for various phytochemicals such as alkaloid, steroids, terpenoids, tannins, phenolic compounds, flavonoids, carbohydrates and amino acids.

Confirmation of Alkaloid
(Mayer Test)

10 mL of the mixture of ethanol and hydrochloric acid (50: 50) was added to 1ml of the ethanolic extract in a test-tube. The mixture was allowed to boil in a water bath for 10 minutes and thereafter filter. The filtrate was then treated with Mayer's reagent the formation of a buff-white yellow precipitate indicates the presence of alkaloids.

Identification of Saponin
Frothing Test

10 mL of the ethanolic extract was diluted with 10 mL of water in a graduated measuring cylinder; it was shaken vigorously and stands for 15 minutes. The formation of foam indicates the presence of Saponin and the height of foam is measured: H_2-H_1.

$$\text{Foam Height} = H_2\text{-}H_1$$

Where H_2 = Final foam height, H_1 = Initial foam height

Identification of Tannins

0.30 g of the powder was weighed into a beaker 30 mL of water was added and brought to a boil for 10 minutes in a water bath. The mixture was then filtered. 5 mL of 1% ferric chloride solution was added to the filtrate and formation of brownish-green coloration confirmed presence of Tannins.

Identification of Steroids / Terpenoids

The steroids analysis was carried out by weighing 0.05 g of the pulverized sample was weighing in to10 mL of hot water followed 3 mL of chloroform in a test tube. The test tube was then tilted with the addition of 2 mL of concentrated sulphuric acid, slowly through the side of the test-tube the presence of a brown-reddish colour at the chloroform phase indicates the presence of steroid / terpenoid.

Identification of Phlobatannin

Condensed tannin was determined by weighing 0.30 g of pulverized sample was weighed into a beaker and 30 mL of distilled water added. After 24 hours 10 mL of the aqueous extract was boiled with 5 mL of 1% aqueous hydrochloric acid. The formation of deposit of red precipitate on the wall of the test-tube indicates presence of Phlobatannin.

Identification of Flavonoids

0.30 g of pulverized sample was weighed into a beaker containing 30 mL of distilled water and stand for 2 hours and filtered.10 mL of the filtrate was mixed with 5 mL of 1.0 M dilute ammonia solution followed by the addition of 5 mL of concentrated tetraoxosulphate (VI) acid. A yellow colour which disappeared on standing revealed the presence of flavonoids.

Identification of Reducing Sugars

In a test tube 1 mL of Fehling solution A and B are added to 2 mL of aqueous extract and boil for 10 minutes. Formation of a brick red precipitate indicates the presence of reducing sugar.

Identification of Glycosides

2.0 g of the powder sample was added to 20 mL of water, it was then heated for 5 minutes on a water bath and filtered through filter paper. 15 mL of 1.0 M sulphuric acid was added to 2 mL of the aqueous extract and boil for 10 minutes, formation of red precipitate indicates the presence of glycosides.

Identification of Phenol

1 mL of the extract was mixed with 2 mL of 1% $FeCl_3$, the presence of blue-black (violet) or blue green coloration indicates the presence of phenol.

3.1.2. Quantitative Analysis of Phytochemicals

Alkaloids Analysis

200 mL of 10% acetic acid in ethanol was added to 2 g of each sample in a 250 mL beaker and allowed to stand for 4 hours. The extract was then concentrated on a water bath to one-quarter of its original volume followed by addition of 15 drops of concentrated ammonium hydroxide dropwise to the extract until the precipitation was complete immediately after filtration. After 3 hours the supernatant was discarded and the precipitates were washed with 20 mL of 0.1 M of ammonium hydroxide and then filtered. The residue was dried in an oven and the percentage alkaloid.

$$\% \text{ Alkaloid} = \frac{\text{Weight of alkaloid}}{\text{Weight of sample}} \times 100$$

Saponin Analysis

100 mL of 20% aqueous ethanol was added to 5 g of each pulverized sample in a 250 mL conical flask. The mixture was heated over a hot water bath for 4 hours with continuous stirring at a temperature of 55°C. The residue was re-extracted with another 100 mL of 20% aqueous ethanol after filtration and heated for 4 hours at a constant temperature of 55°C with constant stirring. The combined extract was evaporated to 40 mL over water bath at 90°C. 20 cm^3 of diethyl ether was added to the concentrate in a 250 mL separating funnel and vigorously agitated from which the aqueous layer was recovered while the ether layer was discarded. This purification process was repeated twice. 60 mL of n-butanol was added and extracted twice with 10 mL of 5% sodium chloride. After discarding the sodium chloride layer, remaining solution was heated in a water bath for 30 minutes, after which the solution was transferred into a crucible and dried in oven a constant weight obtained.

$$\% \text{ Saponin} = \frac{\text{Weight of Saponin}}{\text{Weight of sample}} \times 100$$

Tannin Analysis

50 g of sodium tungstate (Na_2WO_4) was dissolved in 37 mL of distilled water (Folin-Denis reagent). 10 g of phosphomolybdic acid ($H_3PMo_{12}O_{40}$) and 25 mL of orthophosphoric acid (H_3PO_4) was added. This was reflux for 2 hours, cooled, and diluted to 500 mL with distilled water. One gram of each (sample) in a conical flask was added to 100 mL of distilled water. This was boiled gently for 1 hour on an electric hot plate and filtered using 125 mm Whatman filter paper in a 100 mL volumetric flask. Addition of 5.0 mL Folin-Denis's reagent and 10 mL of saturated Na_2CO_3 solution into 50 mL of distilled water followed by 10 mL of extract (aliquot volume) pipetted into a 100 mL standard flask. The solution was allowed to stand for 30 minutes in a water bath at a temperature of 25°C after thorough agitation. With the aid of UV/VIS spectrophotometer optical density was measured at 700 nm and compared on a standard tannic acid curve.

Preparation of Tannic acid for UV/VIS'S absorbance

0.20 g of tannic acid was dissolved in distilled water and dilution to 250 mL standard flask (1mg/ml) were used to obtain tannic standard curve. Varying concentrations (0.2–1.0 mg/mL) of the standard tannic acid solution were pipetted into five different test tubes to which Folin-Denis reagent (5 mL) and saturated Na_2CO_3 (10 mL) solution were added and made up to the 100 cm^3 mark with distilled water. The solution was left to stand for 30 minutes in a water bath at 25°C. Optical density was ascertained at 700 nm using UV/VIS spectrophotometer. Optical density (absorbance) versus tannic acid concentration was plotted.

$$\text{Tannic acid (mg /100 g)} = \frac{C \times \text{extract volume} \times 100}{\text{Aliquot volume} \times \text{weight of sample}}$$

where C is concentration of tannic acid read off the graph.

Test for Phenols

2 g of pulverized sample was defatted for 2 hours in 100 mL of diethyl ether using a Soxhlet apparatus. The defatted sample (0.5 g) was boiled for 15 minutes with 50 mL of ether for the extraction of the phenolic components. 2 mL of 0.1 N ammonium hydroxide solutions, 5 mL of concentrated amyl alcohol were added 10 mL of distilled water followed by 5 mL of the extract and left to react for 30minutes for color development. The optical density was measured at 505nm. 0.2 g of tannic acid was dissolving in distilled water and diluted to 250 mL mark (1 mg/mL) in preparation for phenol standard curve. Varying concentrations (0.2–1.0 mg/mL) of the standard tannic acid solution were pipetted into five different test tubes to which 2 cm^3 of NH_3OH, 5ml of amyl alcohol, and 10 mL of water were added. The solution was made up to 100 mL volume and left to react for 30 minutes for color development. The optical density was determined at 505 nm with UV/VIS TG 50 spectrophotometer.

$$\text{Phenolic acid (mg /10 0 g)} = \frac{C \times \text{extract volume} \times 100}{\text{Aliquot volume} \times \text{weight of sample}}$$

Where C is concentration of tannic acid read off the graph

Flavonoid Analysis

50 ml of 80% aqueous methanol added was added to 2.5 g of sample in a 250 mL beaker, covered, and allowed to stand for 24 hours at room temperature. After discarding the supernatant, the residue was re-extracted (three times) with the same volume of ethanol. The solution was then filtered and transferred into a crucible and then evaporated to dryness over a water bath. The content in the crucible was cooled in a desiccator, weighed and recorded until constant weight was obtained.

$$\% \text{ Flavonoid} = \frac{\text{Weight of Saponin}}{\text{Weight of sample}} \times 100$$

Reducing Sugar

The reducing sugar content (RSC) can be determined using the 3, 5-dinitrosalicylic acid (DNSA) method. The measurement was performed according to the procedure of Krivorotova & Sereikaite, [61].

1g of DNSA and 30g of sodium-potassium tartaric acid were dissolved in 80 mL of 0.5 N NaOH at 45°C. After dissolution, the solution was allowed to cool to room temperature and diluted to 100 mL with distilled water. 2 mL of DNSA reagent was then pipetted into a test tube containing 1 mL of plant extract (1 mg/mL) and kept at 95°C for 5 min. After cooling, 7 mL of distilled water was added to the solution and the absorbance of the resulting solution was measured at 540 nm using a UV-VIS spectrophotometer (Shimadzu UV-1800). The reducing sugar content was calculated from the calibration curve of standard D-glucose (200-1000 mg/L), and the results were expressed as mg D-glucose equivalent (GE) per gram dry extract weight.

$$\text{Reducing Sugar (mg /100 g)} = \frac{C \times \text{extract volume} \times 100}{\text{Aliquot volume} \times \text{weight of sample}}$$

3.2. Phytochemical Screening Analysis

3.2.1. Qualitative and Quantitative Phytochemical Screening

The results of qualitative and quantitative phytochemical constituents analyzed revealed the presence of several important secondary metabolites such as alkaloids, tannins, phlobatannins, saponins, terpenoids, cardiac glycosides, steroids, reducing sugars, flavonoids and phenols in both aqueous and ethanol extracts. Generally, higher quantitative values was observed for ethanol extracts compared to the aqueous extracts, suggesting enhanced extraction efficiency of neuroactive constituents.

Table 2. *Qualitative Synthetic Psychoactive Compounds.*

Code	Alkaloid	Tannin	Phloba Tannin	Saponnin	Terpenoid	Cardiac Glycosides	Steroid	Reducing Sugar	Flavonoid	Phenol
				Ethanol	Extract					
MM2	++	+	+	++	+	+	+	+	+	+
JW2	+	+	+	+++	+	+	+	+	+	+
EG2	++	+	+	+++	+	+	+	+	+	++
IY2	++	+	+	++	+	+	+	+	+	++
KA2	+	+	+	++	+	+	+	+	+	+
TT	++	+	+	++	+	+	+	+	+	++
				Aqueous	Extract					

Code	Alkaloid	Tannin	Phloba Tannin	Sapon-nin	Terpe-noid	Cardiac Glycosides	Steroid	Reducing Sugar	Flavo-noid	Phenol
IY1	+	+	+	+	+	+	+	+	+	+
TT1	+	+	+	+	+	+	+	+	+	+
JW1	++	+	+	+	+	+	+	+	+	++
EG1	+	+	+	+	+	+	+	+	+	+
SS1	+	+	+	+	+	+	+	+	+	+
MM1	+	+	+	+	+	+	+	+	+	+
KA1	+	+	+	+	+	+	+	+	+	+

+ = Present, ++ = Much in Abundance, - = Absent

3.2.2. Quantitative Phytochemical Analysis of Psychoactive Mixtures

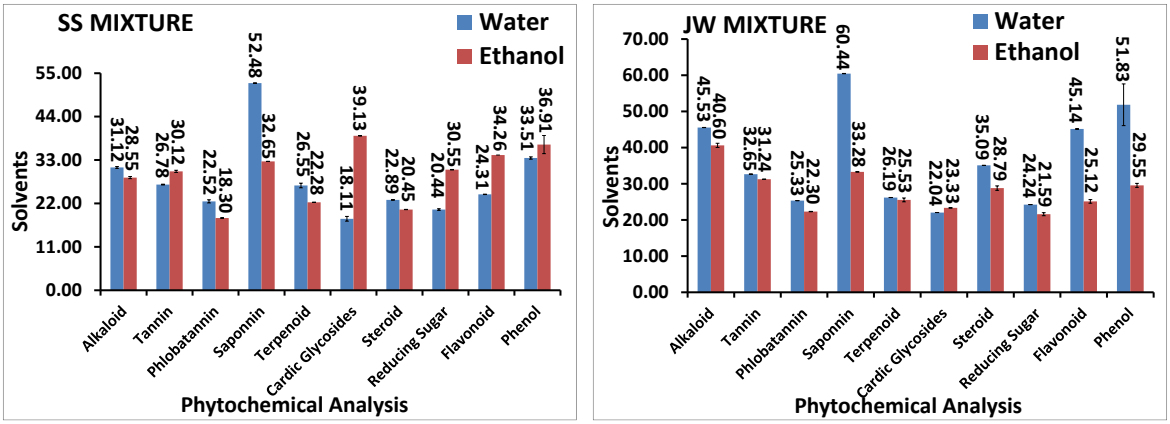

Figure 3. Quantitative analysis of SS and JW psychoactive mixtures.

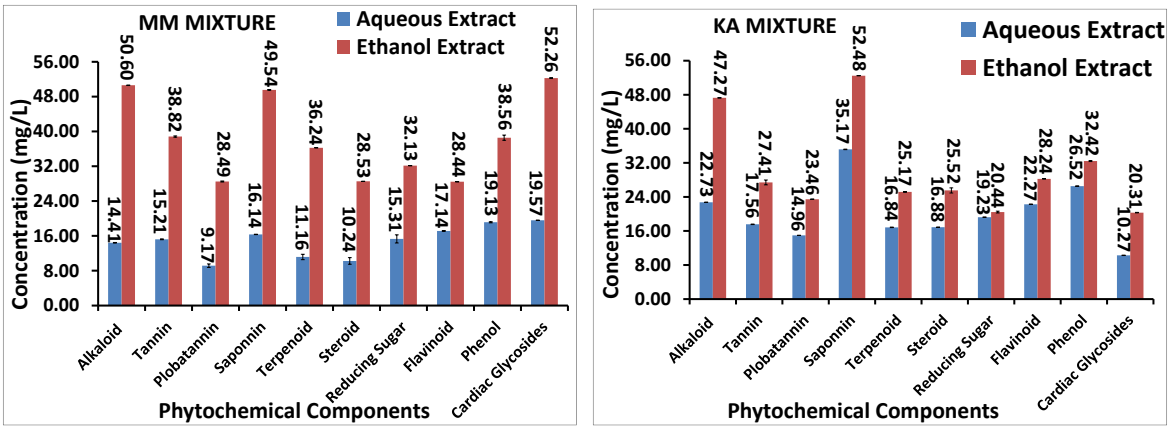

Figure 4. Quantitative analysis of MM and KA psychoactive mixtures.

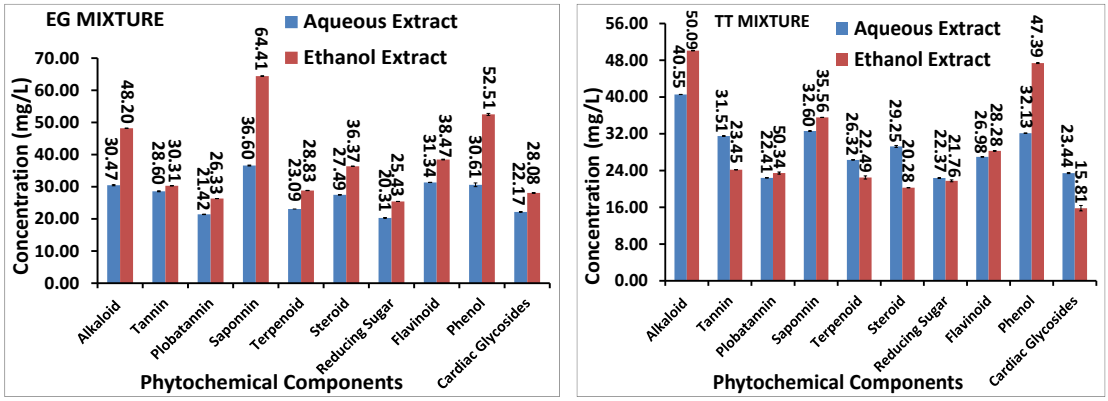

Figure 5. Quantitative analysis of EG and TT psychoactive mixtures.

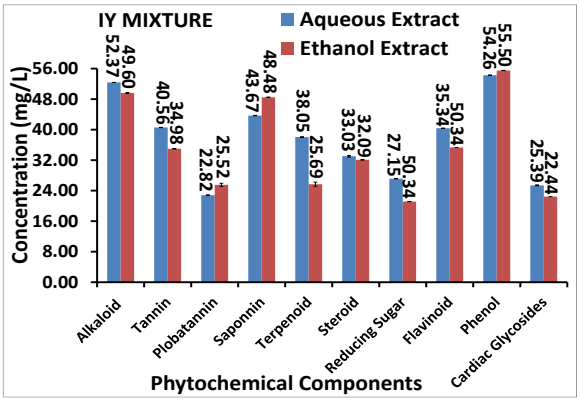

Figure 6. Quantitative analysis of IY psychoactive mixture.

Table 3. Qualitative Analysis of Synthetic Psychoactive Compounds.

Code	Alkaloids	Tan-nin	Phloba Tan-nin	Saponin	Phenol	Reducing Sugar	Steroids	Cardiac Glycoside	Terpe Noids	Flavo Noids
			Aqueous	Extract						
T1	++	+	+	+	+	+	+	+	+	++
S1	+	+	-	++	+	+	+	+	+	+
V1	+	+	+	++	+	+	+	+	+	+
Q1	+	+	-	++	+	+	+	+	+	++
R1	++	+	+	++	+	+	+	+	+	+
P1	++	+	+	++	+	+	+	+	+	+
			Ethanol	Extract						
T2	++	+	+	++	++	+	+	+	+	++
S2	+	+	+	++	+	+	+	+	+	++
V2	++	+	+	++	+	+	+	+	+	+
Q2	++	+	++	+	++	+	+	+	++	++
R2	++	+	+	+	+	+	+	+	+	++
P2	++	+	+	++	+	++	+	+	+	+

+ = Present ++ = Much Present - = Absent

Table 4. Psychoactive substances and their codes.

SYNTHETIC	CODE	MIXTURE	CODE
Arizona	V	Gutter water	CA
Monkey-tail	P	Saponsapon	SS
Molly	M	Jediwewe	JW
Loud	R	Ele	DL
Colorado	T	Jekonmo	CN
Scottish weed	S	Skuchies	EG
		Iyere	IY

3.2.3. Quantitative Phytochemical Screening

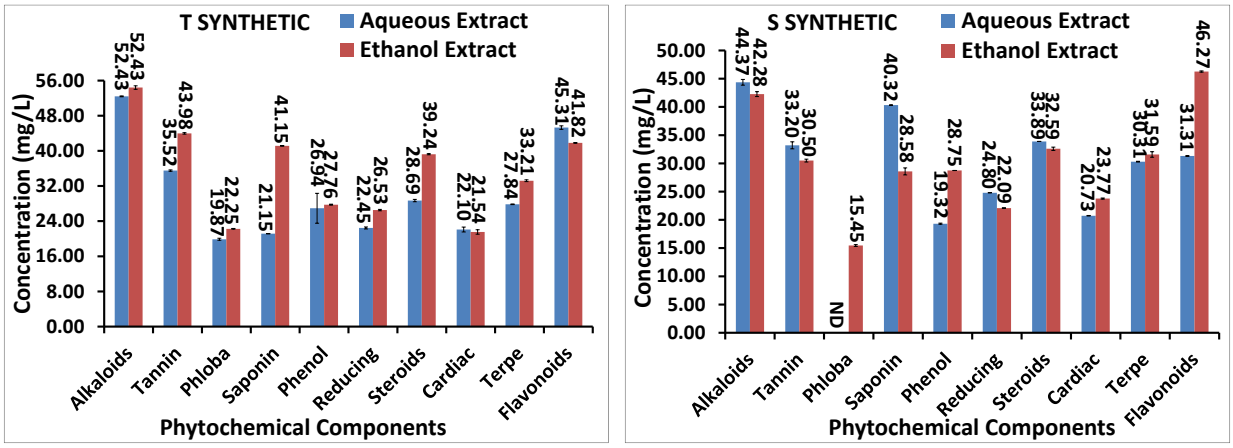

Figure 7. Quantitative analysis of T and S synthetic psychoactive samples.

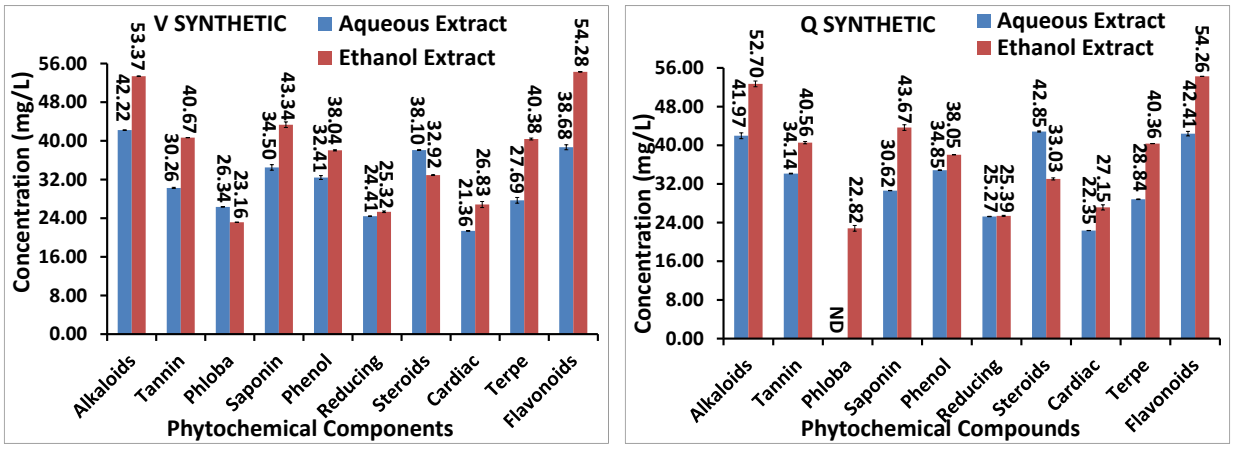

Figure 8. Quantitative analysis of V and Q synthetic psychoactive samples.

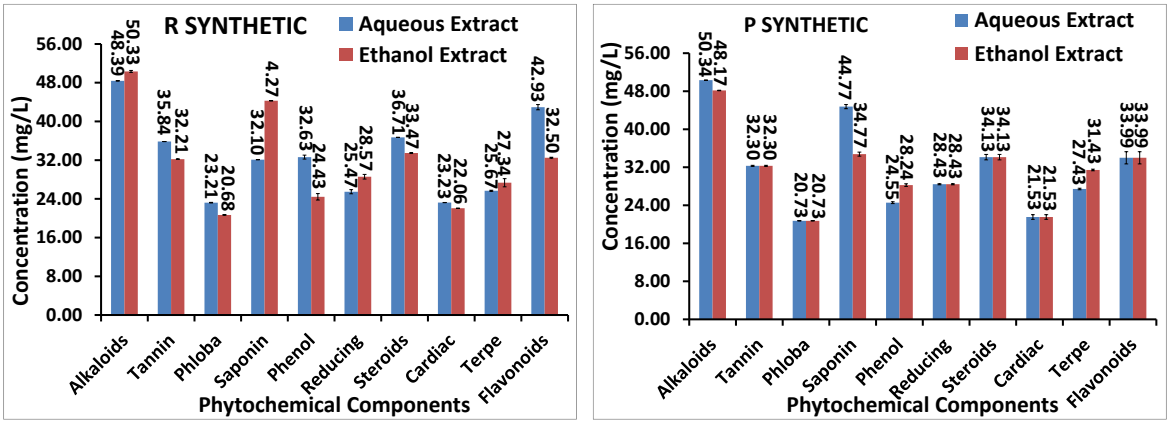

Figure 9. Quantitative analysis of R and P synthetic psychoactive samples.

4. Discussion

The qualitative and quantitative phytochemical analysis carried out in this study revealed the presence of several important secondary metabolites such as alkaloids, tannins, phlobatannins, saponins, terpenoids, cardiac glycosides, steroids, reducing sugars, flavonoids and phenols in both aqueous and ethanol extracts of the samples (Tables 2, 3 and Figures 3-9). These phytochemicals were detected in varying concentrations across the samples, suggesting that the materials analyzed possess significant bioactive potential [62, 63]. Many of these compounds have been widely reported in literature to contribute to neurological and psychoactive effects, which may explain the behavioral or pharmacological properties associated with such substances [37, 40]. In ethanol extracts (MM, JW, EG, IY, KA, TT), several phytochemicals such as saponins, alkaloids, and flavonoids were observed in higher abundance compared with the aqueous extracts (IY, TT, JW, EG, SS, MM, KA). Similarly, in the synthetic samples, the phytochemical results of the aqueous (T, S, V, Q, R, P) and ethanol (T, S, V, Q, R, P) extracts revealed the presence of multiple secondary metabolites with established neuropharmacological relevance, ethanol extracts also demonstrated stronger phytochemical presence than aqueous extracts. This observation suggests that ethanol extraction enhances the recovery of secondary metabolites due to its ability to dissolve both polar and moderately non-polar compounds.

The qualitative analysis showed that most of the tested phytochemicals were present in both extracts, although the ethanol extracts generally exhibited stronger presence (++ or +++) compared with the aqueous extracts. In Table 1 and Figures 3-6 samples such as JW and EG showed very high abundance (+++) of saponins, while several ethanol extracts such as MM, IY and TT showed high presence of alkaloids and flavonoids. In contrast, the aqueous extracts mostly showed moderate presence (+) of these phytochemicals. The higher phytochemical intensity observed in ethanol extracts suggests that ethanol is a more efficient solvent for extracting bioactive secondary metabolites than water. This observation agrees with findings reported by Agidew [64] and Chibuye *et al.,* [65], who noted that organic solvents such as ethanol are capable of dissolving a wider range of phytochemicals due to their intermediate polarity. Consequently, ethanol extraction often yields higher concentrations of alkaloids, flavonoids and phenolic compounds than aqueous extraction.

The phytochemical composition of the natural and synthetic samples revealed several similarities. Both groups contained major phytochemical classes such as alkaloids, flavonoids, saponins and phenolic compounds. However, some differences were observed in their concentration levels. Alkaloids were found in relatively high concentrations across both natural and synthetic samples (Table 3 and Figures 7-9. In the ethanol extracts of natural samples, alkaloid concentrations ranged approximately from 31.23 mg/100 g to about 50.68 mg/100 g, while the aqueous extracts recorded values ranging from 23.01 mg/100 g to about 52.48 mg/100 g). The ethanol extracts Q2 showed high levels of flavonoids (approximately 54.26 mg/100 g) and phenols (approximately 38.08 mg/100 g), indicating strong bioactive potential. The results were in good agreement with reported by Hameed *et al.,* [55]. The high presence of alkaloids is particularly significant because alkaloids are well known for their psychoactive properties. The high alkaloid content observed in this study therefore suggests a potential contribution to psychoactive activity. The synthetic samples generally showed higher concentrations of certain phytochemicals, particularly alkaloids and flavonoids in ethanol extracts. As a result, both natural and synthetic samples may exhibit similar psychoactive or neuropharmacological effects, although the potency and mechanism of action may differ.

5. Conclusion

Overall, results of this study demonstrate that the samples contain a wide range of bioactive phytochemicals with potential neurological and psychoactive significance. The ethanol extracts

generally exhibited higher concentrations of these compounds than the aqueous extracts, highlighting the effectiveness of ethanol as an extraction solvent. The presence of alkaloids, saponins, flavonoids and phenolic compounds supports the possibility that the samples may exert psychoactive, neuroprotective or central nervous system effects, consistent with findings reported in previous phytochemical and pharmacological studies. The presence of these compounds in synthetic samples is important because many psychoactive substances contain functional groups or structures that resemble naturally occurring phytochemicals, particularly alkaloids and phenolic compounds. These compounds can interact with neurotransmitter systems such as dopamine, serotonin and gamma-aminobutyric acid (GABA) pathways in the brain, which are commonly involved in psychoactive responses.

Abbreviations

RSC	Reducing Sugar Content
NCM	Non-Conventional mixture
GC-MS	Gas Chromatography-Mass Spectrometry
UV-VIS	Ultra Violet-Visible
HPLC	High Liquid Performance Chormatography
E. D. T. A	Ethylene Diammine Tetra Acetic Acid

Author Contributions

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Conflicts of Interest

The authors have no conflict.

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