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GC-MS Characterization and Phytochemical Determination of *Buchholzia coriacea* Seeds: Insights into Its Ethnomedicinal Potential

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Abstract:*Buchholzia coriacea seeds are widely used in African traditional medicine for the management of various ailments, earning the plant the common name "wonderful kola." This study evaluated the quantitative phytochemical composition and GC–MS profile of the ethanolic extract of B. coriacea seeds to identify its major bioactive constituents and provide chemical evidence supporting its ethnomedicinal use. Standard phytochemical methods and gas chromatography–mass spectrometry (GC–MS) were employed for the analyses. Quantitative phytochemical analysis revealed the presence of tannins (7.12%), alkaloids (3.26%), saponins (2.41%), phenolics (1.93%), and flavonoids (1.23%), with tannins being the predominant phytochemical. GC–MS analysis identified eleven volatile and semi-volatile compounds, of which cis-9-octadecenoic acid (26.84%), 2-methyl-pyrrolidine-2-carboxylic acid (24.30%), and 5-hydroxymethylfurfural (17.97%) were the major constituents. Published literature indicates that many of these compounds are associated with antioxidant, antimicrobial, anti-inflammatory, cardioprotective, and neuroprotective activities. The diversity of the identified phytochemicals and GC–MS constituents suggests that the medicinal properties of B. coriacea seeds may result from the combined action of multiple bioactive compounds. This study provides chemical evidence supporting the traditional use of B. coriacea seeds and identifies them as a promising source of bioactive secondary metabolites for further pharmacological and phytochemical investigations*

Keywords: *Buchholzia coriacea Seeds, extract, medicinal values*

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1.0 Introduction

Medicinal plants play significant roles in primary healthcare systems, particularly in developing countries where there is limited access to conventional medicines. They have also become an important source of novel bioactive compounds for modern pharmaceutical research, contributing significantly to the discovery and development of new therapeutic agents for infectious, metabolic, cardiovascular, and neurodegenerative diseases.A large proportion of the global population depends on plant-based remedies for microbial infections, metabolic diseases, neurological disorders, and inflammatory conditions (World Health Organization, 2021). More than 70% of people in developing countries utilize traditional medicine also known as "alternative", "complementary "or "nonconventional" medicines for treating diseases (Anyanwu *et al*., 2021). This reliance is largely attributed to the fact that natural products contain structurally diverse bioactive compounds with broad pharmacological activities, making them valuable sources for the development of new therapeutic agents (Njoku *et al*., 2025a).(Njoku *et al*., 2025a).

The reliance on plant-based remedies has inspired increasing scientific interest into the phytochemical and pharmacological evaluation of medicinal plants, identification, and isolation of novel therapeutic agents in order to validate their traditional uses (Wang *et al*., 2025). However, the problems of antimicrobial resistance, adverse reactions, side-effects, limited access, and high costs associated with conventional synthetic medicines, necessitate an urgency for scientific research to focus towards use of local medicinal plants as valuable sources of bioactive compounds (Abdallah *et al*., 2023; Ekor, 2014). Although numerous medicinal plants have demonstrated promising pharmacological properties, only a relatively small proportion has undergone comprehensive phytochemical characterization and pharmacological validation. Consequently, there remains a need for systematic studies that combine phytochemical profiling with advanced analytical techniques to identify the specific bioactive constituents responsible for their therapeutic effects (Wang *et al*., 2025). Consequently, systematic phytochemical characterization of medicinal plants has become increasingly important for validating traditional claims, identifying novel therapeutic compounds, and supporting evidence-based herbal medicine.

Buchholzia coriacea (Engler), commonly known as "wonderful kola" is among the medicinal plants that have been used extensively by traditional herbal practitioners in Nigeria. It is an evergreen shrub belonging to the family Capparaceae and is widely distributed throughout the tropical regions of West and Central Africa, including Nigeria, Cameroon, Ghana, Gabon, the Central African Republic, and Angola (Erhirhie *et al*., 2015). It is characterized by a smooth bark that ranges from dark green to blackish-brown colour. The plant was named after R. W. Buchholz, a German explorer who first collected the species in Cameroon in the late 19th century (Burkill, 2000; Feng & Iheanacho, 2025). In Nigeria, the seeds of wonderful kola are either cooked or eaten raw, to enhance memory and vitality.

Previous phytochemical investigations have consistently reported the presence of alkaloids, tannins, saponins, cardiac glycosides, steroids, carbohydrates, and phenolic compounds in *Buchholzia coriacea*. These secondary metabolites are believed to be responsible for many of the plant's reported pharmacological properties, including antimicrobial, antioxidant, anti-inflammatory, and antidiabetic activities (Nwankwo *et al*., 2018). Despite these reports, previous investigations have mainly focused on identifying broad classes of phytochemicals without adequately characterizing the individual compounds responsible for the reported biological activities. Consequently, the specific chemical constituents underlying many of the ethnomedicinal applications of *B. coriacea* remain insufficiently understood.IIzah *et al*. (2019) and Njoku *et al*. (2025b) reported that *B. coriacea* possesses diverse pharmacological activities, including antimicrobial, antimalarial, antihypertensive, antidiabetic, antioxidant, anti-inflammatory, anti-ulcer, antiparasitic, hypolipidemic, neuroprotective, and anticancer effects. Consequently, the seeds have been traditionally used in the management of fever, cough, asthma, diabetes, ulcers, rheumatism, headaches, gastrointestinal disorders, helminth infections, and several other ailments. While these studies provide substantial evidence of the broad therapeutic potential of *B. coriacea*, most of the reported pharmacological activities are based on preliminary phytochemical screening, crude extract bioassays, or ethnobotanical observations. Detailed chemical characterization linking individual bioactive compounds to specific biological activities remains limited.. The plant has been effective toward fever, cough and asthma, diabetes, headache, sinusitis, catarrh, small pox, scabies, chest pains, boils, syphilis, earache, headache, gonorrhea, rheumatism, cold and catarrh, impotence, ulcers, migraine headaches, worm infestation. Understanding the chemical composition responsible for these therapeutic properties requires the application of advanced analytical techniques capable of identifying individual bioactive constituents.

Gas Chromatography-Mass Spectrometry (GC-MS) has become an important, reliable and adaptable instrumental technique, for characterizing plant extracts to detect volatile and semi-volatile constituents. The technique involves employing gas chromatography (GC) to separate complex chemical mixtures, subsequently, mass spectrometry (MS) which is coupled to the GC identifies the molecular structures of the individual components. ndividual compounds are identified by comparing their retention times and mass spectral fragmentation patterns with reference spectra contained in the National Institute of Standards and Technology (NIST) spectral library (Torres Flores *et al*., 2026).This technique enables bioactive compounds from plant extracts containing complex mixtures to be detected rapidly. It is also useful in relating detected compounds with documented pharmacological activities, and ethnomedicinal applications. GC–MS has been widely employed in natural products research because it enables rapid and reliable identification of volatile and semi-volatile phytochemicals. Previous studies on medicinal plants have demonstrated that GC–MS profiling provides valuable insights into the chemical constituents responsible for antimicrobial, antioxidant, anti-inflammatory, and other pharmacological activities. However, relatively few studies have comprehensively applied this technique to characterize the seed constituents of *Buchholzia coriacea*.

Previous GC-MS investigations of medicinal plants have demonstrated the effectiveness of this analytical technique in identifying volatile and semi-volatile bioactive compounds responsible for various biological activities. However, comprehensive GC-MS characterization of *Buchholzia coriacea* seeds remains limited, particularly studies that integrate compound identification with quantitative phytochemical evaluation and ethnomedicinal interpretation.

Although previous investigations have reported the phytochemical composition and medicinal properties of *Buchholzia coriacea*, most studies have been restricted to preliminary qualitative phytochemical screening or isolated biological evaluations. Comprehensive investigations integrating quantitative phytochemical determination, GC-MS characterization of individual bioactive constituents, and interpretation of their pharmacological relevance to ethnomedicinal applications remain scarce. Consequently, there is limited scientific evidence linking the chemical composition of *B. coriacea* seeds with their documented traditional therapeutic uses. To the best of our knowledge, no previous study has comprehensively integrated quantitative phytochemical determination, GC–MS characterization of the ethanolic seed extract, and interpretation of the identified compounds in relation to the documented ethnomedicinal uses of *Buchholzia coriacea*.Therefore, the present study aimed to quantitatively determine the phytochemical constituents of the ethanolic seed extract of *Buchholzia coriacea*, characterize its volatile and semi-volatile compounds using gas chromatography-mass spectrometry (GC-MS), and correlate the identified constituents with their documented pharmacological activities and ethnomedicinal applications.The findings of this study provide scientific evidence supporting the traditional medicinal use of *Buchholzia coriacea* seeds, enhance current knowledge of their phytochemical composition, and identify bioactive compounds with potential pharmaceutical and nutraceutical applications. Furthermore, the study establishes a valuable scientific basis for future isolation, pharmacological evaluation, and drug development from this important African medicinal plant..

22.0 Materials and Methods

2.1 Materials

Fresh seeds of *Buchholzia coriacea* (wonderful kola) were used for this study. The materials included distilled water, a stainless-steel knife, an electric grinder, an amber-coloured airtight sample container, beakers, measuring cylinders, 50 and 250 mL volumetric flasks, a 250 mL separating funnel, crucibles, Whatman No. 1 filter paper, a water bath, a laboratory oven, a mechanical shaker, an analytical balance, a UV–Visible spectrophotometer, a Heidolph rotary evaporator, a Shimadzu GC–MS QP2010 system, micropipettes, and standard laboratory glassware. Compound identification was performed using the National Institute of Standards and Technology (NIST14) Mass Spectral Library.

2.1.1 Chemicals and Reagents

Analytical-grade ethanol, acetic acid (20% in ethanol), concentrated ammonium hydroxide, Mayer's reagent, Dragendorff's reagent, diethyl ether, *n*-butanol, 5% aqueous sodium chloride solution, tannic acid standard, Folin–Denis reagent, Folin–Ciocalteu reagent, saturated sodium carbonate solution (Na_2CO_3), 80% aqueous methanol, hydrochloric acid (HCl), magnesium turnings (Shinoda reagent), ferric chloride ($FeCl_3$), potassium ferrocyanide [$K_4Fe(CN)_6 \cdot 3H_2O$], and catechol standard were used. All chemicals and reagents were of analytical (Analar) grade).

2.1.2 Collection and Identification of Plant Material

Fresh seeds of *Buchholzia coriacea* were collected from a family garden at Ihitte-Ubi, Isiala-Oparanadim, Ahiazu Mbaise Local Government Area, Imo State, Nigeria. The plant was identified and authenticated by Dr. Catherine Evans-Kemka, Department of Biology, Alvan Ikoku Federal University of Education, Owerri, Nigeria, following standard botanical procedures (Florida Museum Newsletters, 2026). A voucher specimen (A.I.F.U.E.-KEMKA 032-2026) was deposited in the university herbarium for future reference.

2.2 Preparation of Plant Material

The seeds were washed thoroughly with distilled water to remove adhering impurities and sliced into small pieces using a stainless-steel knife. The sliced seeds were air-dried at room temperature for seven days and then ground into a fine powder using an electric grinder. The powdered sample was stored in a clean, airtight amber-coloured container until extraction.

2.2.1 Extraction Procedure

A 512 g portion of the powdered sample was macerated in 500 mL of ethanol for 48 h with intermittent shaking to enhance extraction. The mixture was filtered through Whatman No. 1 filter paper, and the filtrate was concentrated under reduced pressure using a Heidolph rotary evaporator at 45 °C. The concentrated extract yielded 58 g of crude extract, corresponding to an extraction yield of 11.3%, c alculated using equation 1

$$Extraction\ yield = \frac{Wt_{crude}}{Wt_{Initial}} \times \frac{100}{1} \quad (1)$$

where Wt_{crude} is the weight of crude sample and $Wt_{Initial}$ is the initial weight od the sample

2.3 GC–MS Analysis

The GC–MS analysis of the ethanolic seed extract of Buchholzia coriacea was carried out at the National Research Institute for Chemical Technology (NARICT), Zaria, Kaduna State, Nigeria, using a Shimadzu GC–MS QP2010 system. The instrument was equipped with a fused-silica capillary column and operated under electron ionization (EI) mode at 70 eV. Helium (99.99% purity) was used as the carrier gas at a constant column flow rate of 1.50 mL min^{-1}. The injector and interface temperatures were maintained at 250 °C, while the ion source temperature was set at 200 °C.

The oven temperature was initially held at 60 °C for 2 min and then programmed according to the instrument method to achieve complete separation of the constituents within a total run time of 24 min. An aliquot of the extract was injected into the GC–MS system under standard operating conditions. Mass spectra were acquired over an appropriate scan range, and compounds were identified by comparing their mass spectra and retention times with those contained in the National Institute of Standards and Technology (NIST14) Mass Spectral Library (Mohsen Ali & Robin, 2025).

2.4 Quantitative Phytochemical Analysis

Quantitative phytochemical analyses were carried out in triplicate using standard analytical methods.

2.4.1 Determination of Alkaloids

Alkaloid content was determined using the method of Harborne (1973), as modified by Longbap *et al.* (2018). Five grams of the powdered sample were extracted with 20% acetic acid in ethanol for 4 h and filtered. The filtrate was concentrated to one-quarter of its original volume, after which concentrated ammonium hydroxide was added dropwise until complete precipitation occurred. The precipitate was collected, dried to constant weight, and weighed. Alkaloid content was calculated using Equation (2).

$$\%\ \text{Alkaloid} = \frac{\text{Weight of alkaloid extract}}{\text{Weight of plant sample}} \times 100 \quad (2)$$

2.4.2 Determination of Saponins

Saponin content was determined according to the method of Obadoni and Ochuko (2001). Twenty grams of the powdered sample were dispersed in 100 mL of 20% ethanol and heated in a water bath at 55 °C for 4 h with continuous stirring. The mixture was filtered, and the residue was re-extracted with 200 mL of 20% ethanol. The combined extracts were concentrated to approximately 40 mL and transferred into a 250 mL separating funnel. Twenty millilitres of diethyl ether were added, and the mixture was shaken vigorously. The ether layer was discarded, while the aqueous layer was retained. The purification step was repeated before extracting with 60 mL of *n*-butanol. The *n*-butanol extract was washed twice with 10 mL of 5% aqueous sodium chloride solution and evaporated to dryness over a water bath. The residue was dried in an oven to constant weight, and the percentage saponin content was calculated using Equation (3).

$$\%\ \text{Saponin} = \frac{\text{Weight of saponin extract}}{\text{Weight of original sample}} \times 100 \quad (3)$$

2.4.3 Determination of Tannins

Tannin content was determined using the spectrophotometric method described by Gupta *et al*. (2013). Briefly, 0.5 g of the powdered sample was mixed with 50 mL of distilled water and stirred for 1 h. The mixture was filtered into a 50 mL volumetric flask and made up to volume with distilled water. A 5 mL aliquot of the filtrate was transferred into a test tube, followed by the addition of 2 mL of 0.1 M ferric chloride ($FeCl_3$) in 0.1 M hydrochloric acid and 0.008 M potassium ferrocyanide [$K_4Fe(CN)_6 \cdot 3H_2O$]. The absorbance was measured at 395 nm using a UV–Visible spectrophotometer, and tannin concentration was determined from a tannic acid calibration curve.

2.4.4 Determination of Flavonoids

Flavonoid content was determined using the method of Odeyemi *et al*. (2023). Ten grams of the powdered sample were repeatedly extracted with 100 mL of 80% aqueous methanol at room temperature. The extract was filtered into a pre-weighed crucible and evaporated to dryness over a water bath. The residue was dried to constant weight, and the flavonoid content was calculated using equation 4

$$\%\ \text{Flavonoids} = \frac{(\text{Weight of crucible+residue}) - (\text{Weight of crucible}) \times 100}{\text{Weight of analysed sample}} \quad (4)$$

2.4.5 Determination of Total Phenolic Content

Total phenolic content was determined using the method of Madhu et al. (2016). Appropriate concentrations of the ethanolic extract were mixed with 0.4 mL of diluted Folin–Ciocalteu reagent (1:10, v/v). After 5 min, 4.0 mL of 20% sodium carbonate solution was added, and the final volume was adjusted to 10 mL with distilled water. The reaction mixture was allowed to stand at room temperature for 90 min before measuring the absorbance at 750 nm using a UV–Visible spectrophotometer. A catechol standard calibration curve was prepared, and the total phenolic content was expressed as milligrams of catechol equivalent per gram of dry extract (mg CE g^{-1}).

3.6 Data analysis

Data analysis was carried out using Microsoft Excel, GraphPad Prism 8. All results are expressed as the mean ± standard deviation (SD) of triplicate determinations, with a significance threshold set at $p < 0.05$.

3.0 Results and Discussion

The GC–MS analysis of the ethanolic seed extract of *Buchholzia coriacea* (Fig. 1) identified eleven compounds (Table 1), whose chemical structures are presented in Fig 3he major constituents were cis-9-octadecenoic acid (26.84%), 2-methyl-pyrrolidine-2-carboxylic acid (24.30%), and 5-hydroxymethylfurfural (17.97%). The mass spectra of these major compounds are shown in Fig. 2. These compounds may contribute to the diverse biological activities traditionally attributed to *B. coriacea* seeds.These compounds may play significant roles in the biological activity of the seeds of *B. coriacea.*

Previous phytochemical investigations of *B. coriacea* have mainly reported the presence of alkaloids, tannins, flavonoids, saponins, and phenolic compounds using qualitative screening methods (Nwankwo *et al*., 2018; Ojo *et al*., 2021). The present GC–MS analysis extends these findings by identifying individual volatile and semi-volatile constituents that may underlie the pharmacological activities previously reported for the species. Differences in compound composition among studies may be attributed to extraction solvent, geographical origin, plant maturity, and analytical conditions. Cyclopentenedione belong to a group of secondary metabolites of higher plants, fungi, algae, cyanobacteria and bacteria. Their biological activities include antifungal, antibacterial, anti-inflammatory, cytostatic and specific enzyme inhibitory activities. The cyclopentenedione skeleton has been detected in a number of substances isolated from the plant kingdom (Sevcíková *et al*., 2014); hence, cyclopentenedione can be viewed as a new group of natural bioactive substances (Sevcíková *et al*., 2014). This compound may contribute to the antiinfective property of *B. coriacea* seeds, which enables the use of the plant to be used in traditional medicine in the treatment of infections (Feng & Iheanacho, 2025).

Tetrazole and its derivatives have attracted much attention because of their unique structure and application as antimicrobial, antihypertensive, antiallergic, antibiotic, and anticonvulsant agents. Recent report points to their anti-inflammatory, antifungal, analgesic, anticancer, antidiabetic, antimycobacterial, antihypertensive, antinociceptive properties, and presence of cyclooxygenase Inhibitors (Jalal 2016). Twelve novel tetrazole derivatives synthesized by Szulczyk *et al*. (2012) were found to be antimicrobial, and non-cytotoxic against normal cell lines. Tetrazole present in the seeds of *B. coriacea* may be contributory to its use in the management of hypertension, as pain relief, and to relief convulsion in traditional herbal practice (Shende & Mahapatra, 2019).

2-Methyl-pyrrolidine-2-carboxylic acid was the second most abundant compound detected, accounting for 24.30% of the total chromatographic area with a retention time of 8.292 min. Although structurally related pyrrolidine derivatives have been reported to possess antibacterial activity (Azeez *et al*., 2020), the presence of this compound may contribute to the antibacterial properties of *B. coriacea* seeds.Oleamide. The results indicated the predominance of fatty acids and their derivatives in the extract suggests that lipid-derived compounds constitute a major chemical class in *B. coriacea* seeds. Fatty acids such as oleic acid and palmitic acid have been widely reported to possess antioxidant, anti-inflammatory, antimicrobial, cardioprotective, and hypolipidemic properties, indicating that they may collectively contribute to the ethnomedicinal value of the plant.The antibacterial activity of pyrrolidine-2-one derivatives has been established by (Azeez *et al*., 2020). This compound may contribute to the antibacterial properties of the seeds of *B. coriacea*, and its use in the treatment of bacterial infections in traditional medicine (Feng & Iheanacho, 2025).

The compound 5- hydroxy methyl furfural (5 – HMF), with an area percentage of 17.97 in the GC-MS analysis, and retention time of 8.662 min was reported by Safo *et al*. (2004) to have potent antisickling property by targeting and ameliorating the primary pathophysiology of hypoxia-induced sickling of erythrocytes (red blood cells [RBC]). Following the encouraging outcome of the preclinical and phase I/II clinical studies of 5-HMF for the treatment of sickle cell disease (SCD), there have been multiple studies suggesting 5-HMF has several other biological or pharmacologic activities, including anti-allergic, antioxidant, anti-hypoxic, anti-ischemic, cognitive improvement, anti-tyrosinase, anti-proliferation, cytoprotective, and anti-inflammatory. The wide range of its effects makes 5-HMF a potential candidate for treating a variety of diseases including cognitive disorders, gout, allergic disorders, anemia, hypoxia, cancers, ischemia, hemorrhagic shock, liver fibrosis, and oxidative injury (Pagare *et al*., 2024). This compound may contribute to the effectiveness the seeds of *B. coriacea* for memory and cognition (Shende & Mahapatra, 2019).

Numerous studies on hexadecanoic acid (palmitic acid) have found that it is effective against fungal activities and possesses pharmaceutical and environmental promising antioxidant capabilities (Ali Ghfil *et al*., 2025). Palmitic acid present in the seed of the plant may be responsible for its use against fungal infections in ethnomedicine (Feng & Iheanacho, 2025).

Methyl-(11E)-octadecenoate (Fatty Acid Methyl Ester) like other methyl esters, is associated with antiinflammatory, antiandrogenic, cancer preventive, dermatitigenic, hypocholesterolemic, 5-alpha reduce inhibitor, anemiagenic, insectifuge, flavor, nematicide, hepatoprotective, antihistaminic, antieczemic, antiacne, antiandrogenic, antiarthritic and anticoronary properties (Sudha *et al*. 2013; Parthipan *et al*, 2015). This compound may be responsible for the use of *B. coriacea* seeds in traditional medicine for heart disease and management of arthritis (Shende & Mahapatra, 2019).

Cis -9-octadecanoic acid with a percentage area of 26.84, and retention time of 21.280 min is a naturally occuring mono saturated omega -9- fatty acid present in olive oil (50-80%), it is stable, and resistant to oxidative degradation. It is commonly used in cosmetics and skincare products as emollient, penetration enhancer, promoting absorption of active ingredients, softening and conditioning skin and hair. In nutrition, it lowers LDL ("bad cholesterol") and increases HDL ("good cholesterol"), thus enhancing heart health (Ataman Chemicals, n.d.). This explains the anticholesterolemic application of *B. coriacea* seeds in ethnomedicine (Adebayo & Oladele, 2012).

9-(Z)-Octadecenamide (Oleamide) is a fatty acid amide, it accumulates selectively in the cerebrospinal fluid of sleep deprived cats and rats. Oleamide has been reported to have effects on a wide range of receptors and neurotransmitter systems especially the centrally acting ones for example, dopamine acetylcholine, serotonin, gamma aminobutyric acid (GABA), cannabinoid and vanilloid among others. This suggests a wide range of central nervous system effects of the compound (Akanmu *et al*., 2007). This compound may contribute to the cognitive supportive role of *B. coriacea* as a 'brain food' in traditional medicine (Shende & Mahapatra, 2019).

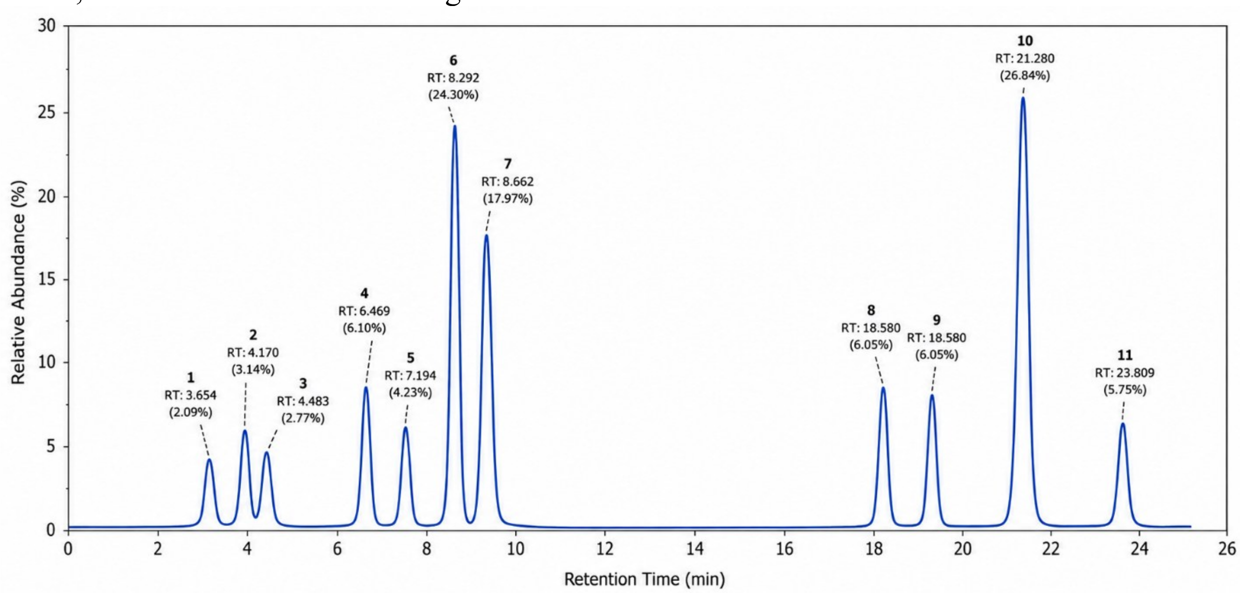


Fig. 1. GC-MS chromatogram of ethanolic extract of seeds of *Buccholzia coriacea*

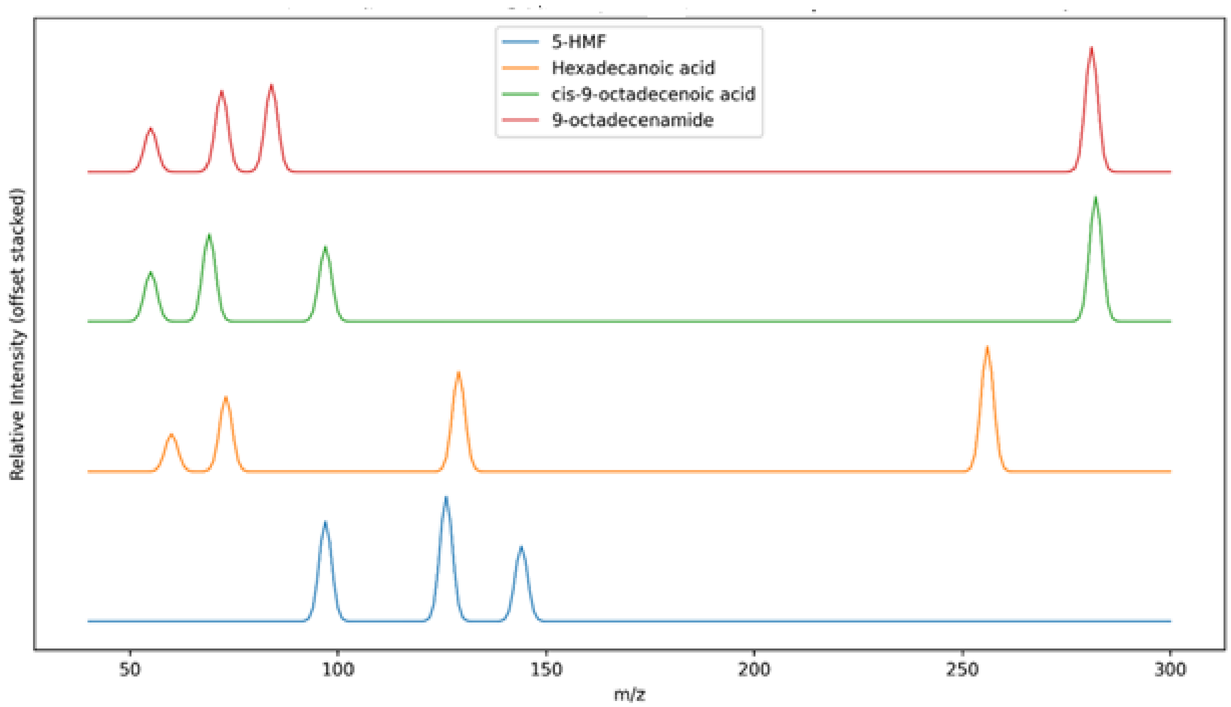
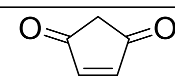
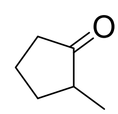
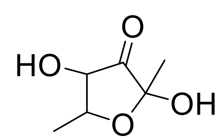
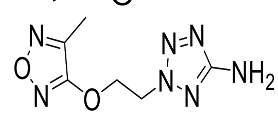
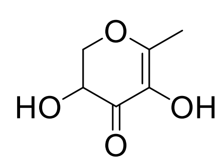
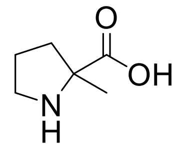
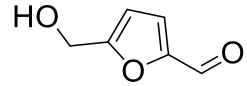
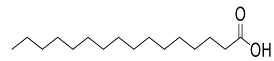
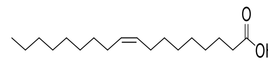
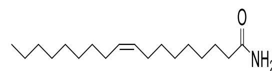


Fig. 2. GC-MS Mass Spectra of three major compounds (stacked layout)

Table 1. Compounds Detected from GC-MS Analysis of *Buchholzia coriacea* Seed

Peak	Compound Name	Molecular Formula	Molecular Weight	Retention Time	Area Percentage	Chemical Structure
1	2-cyclopentene-1,4-dione	$C_5H_4O_2$	96	3.654	2.09	
2	2-methylcyclopentanone	C_6H_{10}	98	4.170	3.14	
3	2,4-dihydroxy-2,5-dimethyl-3(2H)-3-one	$C_6H_8O_4$	144	4.483	2.77	
4	2-[2-(4-methylfurazan-3yloxy)-ethyl]-2H-tetrazol-5-ylamine	$C_6H_9N_7O_2$	211	6.469	6.10	
5	3,5-dihydroxy-6-Methyl-2,3-dihydro -4H-pyran-4-one	$C_6H_8O_4$	144	7.194	4.23	

6	2-methyl-pyrrolidine-2-carboxylic acid	$C_6H_{11}NO_2$	129	8.292	24.30	
7	5-hydroxymethylfurfural	$C_6H_6O_3$	126	8.662	17.97	
8	Hexadecanoic acid	$C_{16}H_{32}O_2$	256	18.580	6.05	
9	Methyl-(11E)-octa decenoate	$C_{19}H_{36}O_2$	296	18.580	6.05	
10	cis-9-octadecenoic acid	$C_{18}H_{34}O_2$	282	21.280	26.84	
11	9-(Z)-octadecenamide	$C_{18}H_{35}NO$	281		5.75	

The phytochemical analysis of ethanolic extract of seeds of *B. Coriacea* in this study as shown in table 2 and figure 3, reveals the presence of alkaloids, tannins, saponins, flavonoids and phenolics in various percentages. Among the phytochemicals quantified, tannins exhibited the highest concentration (7.12%), followed by alkaloids (3.26%), saponins (2.41%), phenolics (1.93%), and flavonoids (1.23%). The predominance of tannins suggests that they may play a significant role in the medicinal properties of the seeds because of their well-documented antioxidant, antimicrobial, and wound-healing activities ((Nasseri *et al*. ,2019).

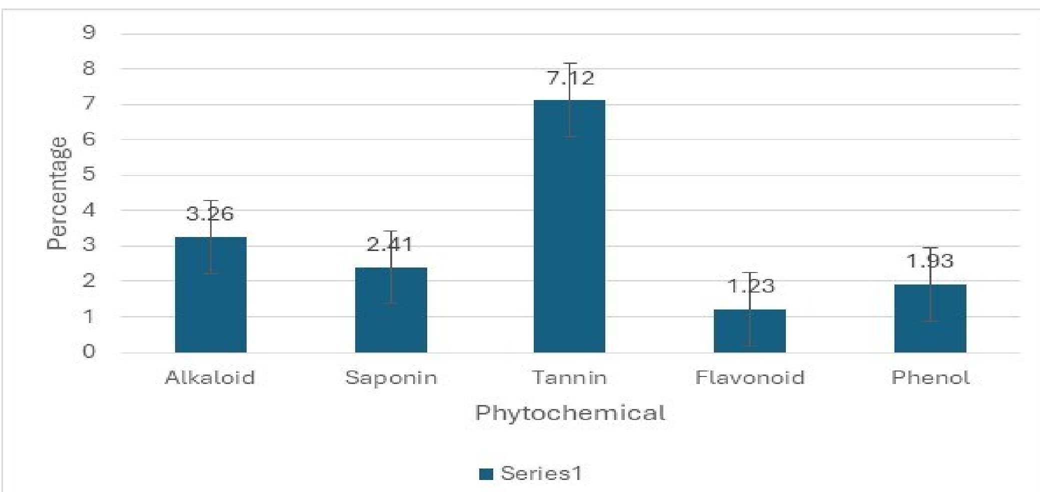


Fig. 3: Bar chart showing the percentage composition of phytochemicals in Buchholzia coriacea ethanolic seed extract

The 3.26% alkaloid content estimated through quantitative phytochemical analysis corroborated the result of GC-MS analysis which detected two alkaloids as compounds 4, (2-[2-(4-methylfurazan-3yloxy)-ethyl]-2H-tetrazol-5-ylamine) and compound 6, (2-methyl-pyrrolidine-2-carboxylic acid). Alkaloids have a wide range of pharmacological activities including antimalarial, antiasthma, anticancer, cholinomimetic, vasodilatory, antiarrhythmic, analgesic, antibacterial, antihyperglycemic (Lu *et al*., 2012; Awuchi 2019). The presence of alkaloids in the seed of *Buchholzia coriacea* gives credence to its use in the treatment of asthma, cough, bacterial infection and malaria in traditional medical practice (Shende & Mahapatra, 2019). The phytochemical profile obtained in this study agrees with previous reports on *B. coriacea*, which identified similar classes of secondary metabolites, although differences in their concentrations have been reported. Such variations may result from differences in extraction solvent, geographical location, climatic conditions, stage of plant maturity, and analytical procedures (Ojo *et al*., 2021; Nwankwo *et al*., 2018).

Saponins present in plants have been known to exhibit diverse biological activities. Saponins are a structurally diverse group of plant-derived glycosides known for their wide range of pharmacological activities. They exhibit antiprotozoal and molluscicidal effects through interactions with membrane sterols, resulting in increased membrane permeability and subsequent cell lysis (Zhong *et al*., 2022). Saponins also demonstrate hypoglycaemic activity by enhancing insulin sensitivity and inhibiting carbohydrate-metabolizing enzymes such as α-glucosidase and α-amylase (Shen *et al*., 2023). In addition, they possess significant antioxidant properties, functioning by scavenging free radicals and upregulating endogenous antioxidant defense systems, including superoxide dismutase and catalase. Their antifungal and antiviral activities are attributed to their ability to disrupt microbial cell membranes and interfere with viral replication processes (Vyshnavi *et al*., 2023). Furthermore, saponins exhibit anti-inflammatory effects by suppressing pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6), as well as inhibiting key signaling pathways like nuclear factor kappa B (NF-κB) (Shen *et al*., 2023). Thus, the presence of saponins [2.41%] in the seed of *B. Coriacea* as detected in this study explains the use of the plant in the treatment of worm infestation, diabetes, cough and skin conditions (Shende & Mahapatra, 2019).

Tannins possess significant wound-healing properties due to their astringent, antimicrobial, and antioxidant activities, which promote tissue contraction and enhance epithelial regeneration (Okwu & Josiah 2006; Agyare *et al*., 2022). The presence of 7.12% tannins in the seeds of *B. coriacea* found in the study supports its traditional use in the treatment of various ulcers and wound related conditions (Salami, *et al*., 2018).

Studies show that phenolic compounds exhibit strong disinfectant properties due to their ability to disrupt microbial cell membranes and denature proteins, leading to cell death. Phenol remains the standard for bactericidal activity of compounds (McDonnell & Russell 2020; Dagli, 2021). Thus, the 1.93% of phenol in *B. coriacea* seed extract underpins the widespread use of phenolic compounds in infection control and supports their relevance in traditional medicinal applications. Flavonoids are widely recognized for their antibacterial, antifungal, and antioxidant activities, which contribute to their protective roles against oxidative stress and microbial infections (Panche *et al*., 2016; Farhadi *et al*., 2022).

The presence of 1.23% flavonoids in the seeds of *B. coriacea* supports its traditional use in the management of various diseases, as these bioactive compounds are known to enhance immune function and inhibit pathogenic microorganisms (Ojo *et al*., 2021; Farhadi *et al*., 2022).

The observed quantitative phytochemical composition and GC–MS profile indicate that *B. coriacea* seeds contain diverse bioactive constituents capable of acting through multiple pharmacological pathways. These findings provide scientif ic support for the traditional medicinal use of the plant and establish a basis for future isolation, pharmacological evaluation, and drug development studies. Collectively, the GC–MS profile indicates that *B. coriacea* seeds contain a chemically diverse mixture of heterocyclic compounds, oxygenated compounds, fatty acids, fatty acid esters, and amides. The coexistence of these compounds suggests possible synergistic interactions that may contribute to the broad spectrum of pharmacological activities reported for the plant in traditional medicine.

Table 2. Percentage phytochemical content of ethanolic extract of *Buchholzia coriacea* seeds.

Phytochemical	Percentage ± sd $(n = 3)$
Alkaloid	3.26 ± 0.22
Saponin	2.41 ± 0.51
Tannin	7.12 ± 0.36
Flavonoid	1.23 ± 0.46
Phenol	1.93 ± 0.27

4.0 Conclusion

This study investigated the GC–MS profile and quantitative phytochemical composition of the ethanolic extract of *Buchholzia coriacea* seeds. Quantitative phytochemical analysis revealed the presence of alkaloids, saponins, tannins, flavonoids, and phenolics, with tannins occurring at the highest concentration and flavonoids at the lowest. GC–MS analysis identified eleven volatile and semi-volatile compounds belonging to ketones, furan and pyran derivatives, fatty acids, esters, heterocyclic compounds, and amides.

Published literature indicates that many of these compounds are associated with antioxidant, antimicrobial, anti-inflammatory, cardioprotective, and neuroprotective activities. Therefore, the phytochemicals and GC–MS-detected constituents identified in this study may contribute to the reported ethnomedicinal uses of *B. coriacea*. The diversity of these bioactive constituents suggests that the medicinal properties of the seeds are likely attributable to the combined action of multiple compounds rather than a single active principle.

This study provides chemical evidence supporting the traditional use of *B. coriacea* and identifies the seeds as a promising source of bioactive secondary metabolites with potential pharmaceutical and nutraceutical applications. However, the biological activities inferred in this study require experimental validation.

Further research should focus on the isolation and structural characterization of the identified compounds, as well as in vitro, in vivo, and in silico pharmacological investigations, toxicity assessments, and mechanistic studies to confirm their therapeutic potential. Similar studies on other parts of the plant are also recommended to facilitate the comprehensive utilization of this valuable medicinal species.

5.0 References

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The authors declared no competing interests

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Authors Contributions

CPN conceptualized the study, conducted collection of sample, prepared the manuscript's first draft, and conducted laboratory analyses. MNN contributed to drafting of the manuscript. BCA contributed to data Analysis and interpretation. BCO contributed to literature search. ISO contributed to drafting of the manuscript. SDU contributed to drafting of the manuscript. AKW contributed to literature search. All authors jointly revised the manuscript, and approved the final version for submission.