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Phytochemical and Essential Oil Characterization of the Aerial Parts of *Leonurus cardiaca* (Motherworth)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

There are numerous medicinal plants in the Southern and Eastern Nigeria. These plants are widely utilized in Nigerian traditional system of medicine for the treatment of countless of illnesses. This paper focused on the phytochemical and essential composition of the aerial parts of *Leonurus cardiaca.* The phytochemical and essential oil screening and characterization were carried out using high performance liquid chromatography and gas chromatography. Results obtained from this investigation showed seven different terpenoids and their total concentrations were 26.19 x 10^{-1} (mg/100 g), nine different phenolic acids (506.33 mg/100 g), twelve different saponin (62.33 mg/100 g), seven different cyanogenic glycosides (118.03 mg/100 g), thirteen different glycosides (16.17 mg/100 g), five (5) different anthocyanins (56.53 mg/100 g), twenty six different alkaloids (1.31 mg/100 g), six different flavonoids (7.31 mg/100 g), seven different sterol (5.91 mg/100 g), tannins (426.49 mg/100 g), and phytate (69.12 mg/100 g). Analysis for essential oils showed fourty one different essential oils (100. 00 %). Our uncovering indicated *Leonurus cardiaca* is an excellent source of terpenoids, saponins, alkaloids, anthraquinones, anthocyanins, phenolic acid, sterols, cyanogenic glycoside, phytate, tannins, glycosides, flavonoids and essential oils. This present research exemplify the preparatory detection for discretion or selection of *Leonurus cardiaca* potential source of novel therapies for the treatment of various diseases.

Keywords: Phytochemicals; Leonurus cardiaca; essential oil; HPLC; gas chromatograph.

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1. INTRODUCTION

The application of medicinal plants have been authenticated in ancient memories for the medicament of countless of disease conditions and they have remodeled progressively significant in the healthcare delivery systems of the global community. Albeit , the adoption of botanical medicine empiric or observational encounter in the past decades, in this days and ages is progressively established on research or knowledge-based documentation with reference to their chemical composition and associated therapeutic effects [1,2].

Essential oils are aromatic, volatile liquids obtained from plant substances through steam purification and are called following the plant from which they are procured. Essential oils can be explicated as products or mixtures of aroma material or as combination of fragrant and odorless substances [3]. The aroma substances are chemically pure compounds that are volatile under normal conditions. They vary greatly, sometimes due to genetic causes and climatic factors including rainfall, or geographic origin. They are made up of principally of lipophilic and highly volatile secondary plant metabolites, principally mono- and sesquiterpenes, but other types of compounds such as allyl and isoallyl phenols may also be present [3].

The curative desirability of these plants reside in chemical structure that give rise to a definitive physiological action on the human body. Meanwhile, the ultimate predominant of these bioactive ingredients of plants are alkaloids, tannins, flavonoids, and phenolic compounds [4]. Numerous of these indigenous medicinal plants are utilized as spices and food plant [5].

Essential oils are aromatic, volatile liquids obtained from plant substances through steam purification and are called following the plant from which they are procured. Essential oils can be explicated as products or mixtures of aroma material or as combination of fragrant and odorless substances [3]. The aroma substances are chemically pure compounds that are volatile under normal conditions. They vary greatly, sometimes due to genetic causes and climatic factors including rainfall, or geographic origin. They are made up of principally of lipophilic and highly volatile secondary plant metabolites, principally mono- and sesquiterpenes, but other types of compounds such as allyl and isoallyl phenols may also be present [3].

Aromatherapy adopt essential oils, as their absolute curative agents, which are said to be highly concentrated substances extracted from flowers, leaves, stalks, fruits and roots, and also distilled from resins [6]. Essential oils represent a mixture of saturated and unsaturated hydrocarbons, alcohol, aldehydes, esters, ethers, ketones, oxides phenols and terpenes, which may produce characteristic odors [7]. They are colorless pleasant smelling liquids with high refractive index. These oils are so potent and concentrated that they work on pressure points and rejuvenate. Medicinal plant (*Euphorbia heterophylla*) contain 46 essential oil sub-members which contribute to its medicinal properties [2].

Leonurus cardiaca L. (common names – *motherwort* in English) represents a perennial herb affiliated to the family *Lamiaceae* family, which grows up to 1 m [6] high, with hollow aerial stalk growing from rhizomes. The leaves of *L. cardiaca* are palmately lobed, being enclosed with stiff hairs. Its flower, are grouped in 10-20 clusters in the leaf's axils of the last 15 knots, are pink and about 1 cm long. The plant originated from Asia and southeastern Europe but is now world-spread owing to it wide medicinal values [7,8]. The prospective application of *Leonurus cardiaca* in healing many heart problems, as well as female-specific afflictions, made *L. cardiaca* a very good candidate for development of alternative treatments, in both traditional eastern and modern medicine [9].

2. MATERIALS AND METHODS

2.1 Materials/Chemicals (Reagents)

High performance liquid chromatography (1200 DAD System, Agilent Technology, Ericino, Califonia, USA), gas chromatography (Model 8610C-SRI), Soxhlet machine (S-1829, Soxhlet-Giant, USA), centrifuge, borosilicate glass flask, screw-capped test-tube, Stopperd flask, Whatzman filter paper1 (542 mm), Spectrophotometer (Spectrumlab 752 S) water bath (PURA 22 JULABO USA, Allenntown, PA18109), magnetic rod, round bottom flask, aqueous ammonia (NH_3), chloroform ($CHCl_3$), hydrochloric acid, hexane, sulphoric acid, petroleum ethers, potassium hydroxide(KOH), benzene, ethanol, methanol, deionized water, paraffin oil, nitrogen steam, potassium permanganate ($KMnO_4$), sodium hydroxide (NaOH), chromatography autosampler vials, phenolic acid standard and ethyl acetate,

Dichloromethane (Lagos), amino acid standards, disposable pipette tips (D-T USA), Vortex mixer (VM-USA), Polypropylene microcentrifuge tubes (Wuhan-China).

2.2 Source and Identification of Plant Material

The fresh aerial parts of *Leonurus cardiaca* (LNC) were harvested from Idema Community, in Ogbia Local Government Area of Bayelsa State, Nigeria. The plant sample was identified and authenticated by Dr. Ekeke Chimezie at the Herbarium Unit of the Department of Plant Science and Biotechnology (PSB), University of Port Harcourt. The sample was registered with Voucher Number UPH/P/203.

2.3 Extraction of Terpenoids

Extraction of terpenoid was carried out based on the modified methods described by 10]. In this method, the sub-terpenoid members were extracted and redistilled with chloroform at an inlet temperature of 150^0C. The terpenoids were removed with 10 ml of chloroform for fifteen (15) minutes. The mixture was then filtered and concentrated to 1 ml in vial for gas chromatography analysis and 1µl of the extract was injected into the injection port of the Gas chromatography at a temperature of 150^0C for the determination of the chromatograms of the different terpenoids (which were detected at a temperature of 300^0C) present in the plant.

2.4 Extraction of Phenolic Acids

Extraction of phenolic acid was carried out in two extraction procedure followed by effective removal of the polyphenolic compounds. The stages of extraction are explained below:

Stage 1: This entails extraction of the sample using sodium hydroxide (NaOH), deionized water, centrifuge, and hydrochloric acid (HCl). Exactly, 5.0 g of the sample was weighed and mixed with 5 ml of 1M NaOH for sixteen (16) hours at an ambient temperature adopting the method as modified by described by [7] and[2]. The mixture was then centrifuge (5000 xg), rinsed with water and centrifuged again. The supernatants obtained was placed on a disposable test tube and was heated at a temperature of 90^0C for two (2) hours in order to release the conjugated phenolic compounds following the methods as explained by [7]. The heated extract was then cooled and titrated with 4 M of HCl to a pH <2.0 which was diluted to 10 ml with deionized water. The extract was again centrifuged for the third time to remove the precipitate while the supernatant was saved for subsequent purification.

Stage 2: This involved extraction of the resulting residue from the stage 1 processes using NaOH and deionized water. In this stage, the residue that resulted from stage 1 procedure was extracted with 5 ml of 4 M NaOH which was heated to a temperature of 160^0C in Telfon following the modified methods as stated by [1]. The mixture was then cooled and filtered using Whatzman filter paper. The supernatant collected and mixed with deionized water. The supernatant was combined and adjusted to pH <2.0 with 4 M HCl while the filtrate was then combine for further purification.

2.4.1 Purification of extracted phenolic acids

With the help of an aliquote (5-15 m L), the various supernatants were passed through a container while the solid phase extraction was placed under a vacuum (-60 kPa) until it was rinsed and thoroughly dried. The phenolic acids were eluted at detection temperature of 320^0C with 1 ml of ethyl acetate into gas chromatography autosampler vials.

2.5 Extraction of Saponins

Saponin was extracted adopting the modified method and procedure as explained by [11]. It involved a three times extraction saponin sub-members, using redistilled methanol. In this method, the saponin was removed with 20 ml of methanol for 20 minutes with the aid of the sonication. The extract was then concentrated to syrup under reduced pressure and suspended in water. The suspension was extracted using petroleum ether, chloroform and 1-butanol saturated with water. The extract was filtered and concentrated to 1 ml in the vial for gas chromatography analysis. Then, 1µl of the extract was injected into the injection port of the Gas chromatography at a temperature of 250^0C for the determination of the chromatograms of the different saponin (which were detected at a temperature of 320^0C) present in the plant.

2.6 Extraction of Cyanogenic Glycosides

Cyanogenic glycoside were extracted using the modified methods and procedures as explained by [11]. In these methods and procedure, 1.0 g of

the pulverized plant sample was soaked for two (2) hours with 10 ml of 70 % alcohol. The mixture was filtered and concentrated to 0.8 g. Exactly, 1 ml of redistilled hexane was added to the extract and further concentrated to 1 ml in vial for Gas chromatography analysis. More so, 1µl of the extract was injected into the injection port of the Gas chromatography at a temperature of 250^0 C for the determination of the chromatograms of the different Cyanogenic glycoside (which were detected at a temperature of 320^0 C) present in the sample.

2.7 Extraction of Glycosides

Glycoside was extracted using the modified methods and procedures as explained by [11]. In these methods and procedure, 1.0 g of the pulverized plant sample was soaked for two (2) hours with 10 ml of 70 % alcohol. The mixture was filtered and concentrated. Exactly, 1 ml of redistilled hexane was added to the extract and further concentrated to 1 ml in vial for Gas chromatography analysis. More so, 1 µl of the extract was injected into the injection port of the Gas chromatography at a temperature of 250^0 C for the determination of the chromatograms of the different glycoside (which were detected at a temperature of 320^0 C) present in the sample.

2.8 Extraction of Anthocyanins

Extraction of anthrocyanin was carried out following the modified method described by [12]. In this method, 5.0g of the sample was weighed into 50 ml borosilicate beaker. Twenty mililiter (20ml) of 50% methanol was added to the mixture and covered with paraffin in a water bath at 80^0C for 1 hour. The mixture was stirred using a magnetic rod to prevent lumping. The mixture was then filtered using a doubled-layer Whatzman filter paper1 (542 mm) into a 100 ml volumetric flask. The filtrate was concentrated to 2 ml in the borosilicate vial for the gas chromatography analysis; 1.0 µl was injected into the injection port of the gas chromatograph at a temperature of 30^0 C and at a wavelength of 535 nm for the determination of the chromatograms of all the different anthocyanins present in the plant expressed in mg/100 g.

2.9 Extraction of Alkaloids

Alkaloids was extracted using the modified method and procedure as explained by [13]. In this method, 5.0 g of the pulverized plant sample was macerated in 25 ml of hexane for seven two (72) hours. The mixture was filtered and the residue was air-dried which was treated with 10 % of aqueous NH_3 macerated into trichloromethane ($CHCl_3$) for twenty four (24) hours. The mixture was filtered an evaporated at a temperature of 250^0 C in a water bath. The resultant crude extract was treated with 5 % of aqueous 7.5 ml hydrochloric acid (HCl) while the aqueous phase was made alkaline with aqueous NH_3. However, the mixture was extracted thrice with $CHCl_3$ while the extract was poured into the round bottom flask of the rotatory evaporator which properly arranged. The crude extract was then concentrated to 2 ml in the borosilicate vial for the gas chromatography analysis; 1.0 µl was injected into the injection port of the gas chromatograph at a temperature of 250^0 C for the determination of the chromatograms of all the different alkaloids present in the plant expressed in mg/100 g.

2.10 Extraction of Flavonoids

Extraction of flavonoids was carried out using the method described by [14]. In this method and procedure, 50.0 g of the powdered sample was weighed and transferred into Stopard flask and treated with 50 ml of ethanol until the powder was fully soaked. The flask was shook one hourly for the first six hour which was kept aside and shook after twenty four (24) hours. The process was repeated for three days and the extract was filtered. The extracted was then collected and evaporated using nitrogen steam to form a concentrated weighing 0.5 g. The 0.5 g was then transferred into a 250 ml conical flask containing 100 ml of deionized water and boiled for 10 minutes. The flavonoid extract was obtained by pouring 100 ml of the boiling methanol in the ratio 70:300 v/v onto the material. The homogenate was then was allowed to macerate for about four (4) hours and then filtered through filter (Whatman No.1). The filtrate was derivatized for volatility through gas chromatography analysis. The mixture was finally concentrated to 2 ml in Agilent through vial for gas chromatography.

2.11 Extraction of Sterols

Extraction of sterols was performed using the modified method described by [11]. In this method, 5.0 g of the powdered plant sample was weighed and transferred into a Stoppard flask and treated with petroleum ether until the powder was fully soaked. The flask was shook very hourly for the first six (6) hours and was kept

aside for twenty four (24) hours. The process was repeated for three days and the extract was filtered. The extract was evaporated to dryness by using nitrogen steam. However, 0.5 of the extract was added to the screw-capped test tube. The sample was saponified at 95^0C for thirty (30) minutes using 3 ml of 10 % potassium hydroxide (KOH) in 3 ml of ethanol containing 0.20 ml of benzene to ensure miscibility. More so, 3 ml of deionized water was added to the mixture and 2 ml of the hexane was used to extract non-saponifiable materials such as sterols. Three extractions each with 2 ml of hexane were carried out for one (1) hour, thirty (30) minutes and thirty nine (39) minutes respectively to achieve complete extraction of sterols. The hexane was concentrated to 2 ml at 320^0C in Agilent vial for Gas chromatography analysis.

2.12 Extraction of Tannin

Extraction of tannin was performed using the method and procedure as described by [15]. In this method and procedure, 0.2 g of the pulverized plant sample was measured into a 50 ml borosilicate beaker. Exactly, 20 ml of 50 % methanol was added, stirred, covered with paraffin oil and placed in a water bath at a temperature of 80^0C for one (1) hour. The content of the mixture was stirred with a glass rod in order to prevent lumping. The extract was filtered using a double layered Whatzman No.1 filter paper into a 100 ml volumetric flask using 50 % of methanol to rinse. The extract was concentrated in the borosilicate vial for the Gas chromatography analysis where, 1.0 micro-litre was injected into the injection port of the Gas chromatography at a temperature of 320^0C for the determination of tannic acid in the plant sample.

2.13 Extraction of Phytate

Extraction of phytate was carried out using the method and procedure as described by [16]. In the [16] method, 4.0 g of pulverized plant sample was weighed and soaked in 100 ml of 2 % hydrochloric acid (HCl) for three (3) hours. The mixture was filtered using Whatzman No.1 filter paper. However, 25 ml of the filtrate was placed in a conical flask and 5 ml of 0.3 % ammonium thiocyanate (NH_4SCN) solution was added to the mixture. Exactly, 53.5 % of distilled water was added and titrated against a standard iron (III) chloride ($FeCl_3$) solution to endpoint. The phytate content obtained was expressed as the percentage (%) phytate in the sample.

2.14 Extraction of Essential Oil

Extraction of essential oil was carried out using the method described by [16]. In this method, 1.0 g of the powdered sample was macerated into 10 ml of hexane in 50 ml borosilicate glass flask for 24 hours. The mixture was filtered and the filtrate was treated with 75 ml of 3 M solution of sulphoric acid which was stirred with a magnetic rod for 1 hour. The mixture was again filtered and the filtrate concentrated to 2 ml in vial for chromatography analysis while 1 µl of the extract was injected into the port of gas chromatograph for the determination of the chromatograms of the different essential oils present in the plant expressed in percentage.

3. RESULTS AND DISCUSION

Table 1 shows the qualitative and quantitative terpenoid compositions of the aerial parts of *Leonurus cardiaca.* Phytochemical composition of terpenoids in the aerial parts of *Leonurus cardiaca* revealed seven different terpenoids expressed in mg/100 g as shown in Table 1. Ajugoside has the highest concentration which was 7.57×10^{-2} mg/100 g followed by bauerenol acetate (5.61×10^{-4} mg/100 g), ajugol (4.59×10^{-1} mg/100 g), beta-amyrin (2.88×10^{-1} mg/100 g), alpha-amyrin (2.09×10^{-1} mg/100 g) and lupeol (2.05×10^{-1} mg/100 g). The least terpenoid concentration was taraxerol (1.40×10^{-1} mg/100 g) while the sum total of all the terpenoid sub-members were 26.19×10^{-1} (mg/100 g) as shown in Table 1.

[14] showed that terpenoids (isoprenoids) which are the largest and most diverse group of naturally occurring compounds that are mostly found in plants are responsible for the fragrance, taste, and pigment of plants. Terpenoids have numerous roles in plants including thermoprotectant, signaling functions, and are merely limited to, pigments, flavoring, and solvents but also have various medicinal uses [17].

[18] reported thatterpenoids have been shown to mediate relaxation effects occur through mechanisms that involve inhibition of Ca2+ influx in vascular smooth muscle or via quenching of reactive oxygen species (ROS) and stimulation of nitric oxide (NO) synthesis. Terpenoids are also can also have a direct impact upon the heart homeoatasis and fuction. Indeed, it has been reported to affect heart rate, electrophysiology, infarcted area, and inhibit myocardial enzymes

such as the creatine kinase (CK), the MB isoenzyme of creatine kinase (CK-MB), lactate dehydrogenase (LDH) and cardiac troponin T (cTnT). Moreover, the cardioprotective potential can be associated with other biological activities of terpenoid namely their antioxidant, anti-apoptotic and anti-inflammatory properties. Anti-apoptotic effects focus on the levels of caspase-3, pro-apoptotic factor Bax and apoptosis regulator Bcl-2 as well as the inhibition of the opening of the mitochondrial permeability transition pore (mPTP) [18]. Alim et al*.* [14] showed that taraxerol elicit many important pharmacological actions including anti-cancer activity, their chemistry, biosynthesis aspects, and possible use of these compounds as drugs in treatment of cancer. In this study, the presence of taraxerol in the aerial parts of *Leonurus cardiaca* prsents the plant as a potent source of novel cancer therapy of different types. Flavia et al*.* [8] reported the antihyperglycemic and hypolipidemic effects of α, β-amyrin and Beta-amyrin a triterpenoid mixture from *Protium heptaphyllum* in mice. α,-amyrin and β—amyrin was characterized from the aerial parts of the plant at an appreciable concentration which speak of as a source of antihyperglycemic and hypolipidemic agent against diabetes and obesity. Hifzur and Mohammad [7] demonstrated that lupeol has a potential to act as an anti-inflammatory, anti-microbial, anti-protozoal, anti-proliferative, anti-invasive, anti-angiogenic and cholesterol lowering agent. Employing various in vitro and in vivo models, lupeol has also been tested for its therapeutic efficiency against conditions including wound healing, diabetes, cardiovascular disease, kidney disease, and arthritis. Lupeol modulates the expression or activity of several molecules such as cytokines IL-2, IL4, IL5, ILβ, proteases, α-glucosidase, cFLIP, Bcl-2 and NFκB. This mini review discusses in detail the preclinical studies conducted with lupeol and provides an insight into its mechanisms of action. However, lupeol was found in the aerial parts of *Leonurus cardiaca* at 2.05 x 10^{-1}mg/kg, indicating that the plant could elicit antimicrobial, anti-proliferative, anti-invasive, anti-angiogenic and hypolipidemic effect in humans when tested.

Table 2 shows the qualitative and quantitative phenolic acid compositions of the aerial parts of *Leonurus cardiaca.* Quantitative phytochemical composition of phenolic acids in the aerial parts of *Leonurus cardiaca* showed nine different phenolic acid expressed in mg/100 g. Chlorogenic acid was the highest in concentration which was 195.33 mg/100 g followed by caffeic acid (115.88x10^{-1} mg/100 g), ferulic acid (87.12 mg/100 g), 4-hydroxybenzoic acid (25.83 mg/100 g), cichoric acid (23.47 mg/100 g), rosmarinic acid (6.91x10^{-3} mg/100 g), gallic acid (2.64x10^{-3} mg/100 g) and protacatechui acid (1.36 mg/100 g). The least was vanillic acid (1.30x10^{-2} mg/100 g) while the total phenolic acid sub-members in the aerial parts of the plant were 506.33 mg/100 g (Table 2).

Phenolic acids are known to possess much higher *in vitro* antioxidant activity than well known antioxidant vitamins [19] and are found in the variety of plant-based foods *viz*. seeds, skins of fruits and leaves of vegetables contain them in highest concentrations [20]. Phenolic acids have been used for enhancing the organoleptic such as flavor, astringency, and hardness, color, sensory qualities, nutritional and antioxidant properties in food items [21,22]. Protacatechuic acid acid, vanillic acid, gallic acid, caffeic acid, ferulic acid, have been shown to elicit antioxidant activity, antibacterial activity, anticancer activity, antiulcer activity, antidiabetic activity, antiageing activity, antifibrotic activity, antiviral activity, anti-inflammatory activity, analgesic activity, antiatherosclerotic activity, cardiac activity, hepatoprotective activity, neurological and nephro protective activity [23]. Protocatechuic acid, acid, vanillic acid, gallic acid, caffeic acid, and ferulic acid are considered as an active component of some traditional Chinese herbal medicines such as *Cibotium barometz* (L.) *J.S, Stenoloma chusanum* (L.) *Ching, Ilex chinensis Sims* [24-27]. In this study, the protacatechuic acid, acid acid, vanillic acid, gallic acid, caffeic acid, ferulic acid, rosmarinic acid, chlorogenic acid, and cichoric acid characterized from the aerial parts of the plant showed that the *Leonurus cardiaca* is a potent source of anti-oxidant,

Table 1. Phytochemical composition of terpenoid content in the aerial parts of *Leonurus cardiaca*

Terpenoids	Concentration (mg/100g)
Taraxerol	1.40 x 10^{-1}
Alpha-amyrin	2.09 x 10^{-1}
Beta-amyrin	2.88 x 10^{-1}
Ajugol	4.59 x 10^{-1}
Lupeol	2.05 x 10^{-1}
Ajugoside	7.57 x 10^{-2}
Bauerenol acetate	5.61 x 10^{-4}
Total	**26.19 x 10^{-1}**

Table 2. Phytochemical composition of phenolic acid content in the aerial parts of *Leonurus cardiaca*

Phenolic acids	Concentration (mg/100 g)
Protacatechui acid	1.36
4-hydroxybenzoic acid	25.83
Vanillic acid	$1.30x10^{-2}$
Gallic acid	$2.64x10^{-3}$
Caffeic acid	$115.88x10^{-1}$
Ferulic acid	87.12
Cichoric acid	23.47
Rosmarinic acid	$6.91x10^{-3}$
Chlorogenic acid	195.33
Total	**506.33**

anticancer, anti-inflammatory, anti-analygesic, and hepatoprotective agents which is in line with the report of Vitaglione et al. [23]. 4-Hydroxy benzoic acid produced antibacterial, antifungal, antialgal, antimutagenic, antisickling and estrogenic activity and it is also used as trapping agent to study hydroxyl radical generation during cerebral ischemia and reperfusion which is also widely used as preservative in drugs, cosmetics, pharmaceuticals, in food and beverages. 4-Hydroxy benzoic acid in the aerial parts *of Leonurus cardiaca* was observed to be highest in concentration, which could be responsible for the immunomodulatory potential of *Leonurus cardiaca* extract in relation to endothelial cells and platelets reported by [28].

Table 3 shows the qualitative and quantitative saponin compositions of the aerial parts of *Leonurus cardiaca.* Quantitative phytochemical composition of saponin in the aerial parts of *Leonurus cardiaca* showed twelve different saponins expressed in mg/100 g as shown in Table 3. Saponine was the highest in concentration which was 28.83 mg/100 g followed by sapogenin (25.56 mg/100 g), sarsasapogenin (2.98 mg/100 g), narthogenin (2.02 mg/100 g), neochlorogenin (1.75 mg/100 g), neotigogenin (1.19 mg/100 g), diosgenin ($9.99x10^{-5}$ mg/100 g), yanogenin ($6.37 x10^{-4}$ mg/100 g), tribuloin ($4.19 x10^{-4}$ mg/100 g), tigogenin ($2.70x10^{-4}$ mg/100 g) and conyzorgin ($1.93 x10^{-5}$ mg/100 g). The least was hecogenin ($1.06x10^{-4}$ mg/100 g) while the sum total of all the saponin sub-members were 62.33 mg/100 g as shown in Table 3.

Saponins possess and elicit several medicinal properties including anti-inflammatory, hypocholesterolaemic, antimicrobial property [29], and immune-stimulating remedies [29,30]. Sapogenins reported in fenugreek include yamogenin, diosgenin, smilagenin, sarsasapogenin, tigogenin, neotigogenin, gitogenin, neogitogenin, yuccagenin, and saponaretin [32]. The Sarsasapogenin, Narthogenin, Diosgenin, Neotigogenin, Tigogenin, Neochlorogenin, Hecogenin, Tribuloin, Yanogenin and Conyzorgin present in the aerial parts of *Leonurus cardiaca* showed that the plant is novel source of anti-lipidemic,

Table 3. Phytochemical composition of Saponins in the aerial parts of *Leonurus cardiaca*

Saponins	Concentration (mg/100 g)
Sarsasapogenin	2.98
Narthogenin	2.02
Diosgenin	$9.99x10^{-5}$
Neotigogenin	1.19
Tigogenin	$2.70x10^{-4}$
Neochlorogenin	1.75
Hecogenin	$1.06x10^{-4}$
Sapogenin	25.56
Tribuloin	$4.19 x10^{-4}$
Yanogenin	$6.37 x10^{-4}$
Conyzorgin	$1.93 x10^{-5}$
Saponine	28.83
Total	**62.33**

anti-microbial, anti-inflammatory agents reported by [29,31].

Table 4 shows the qualitative and quantitative cyanogenic glycoside compositions of the aerial parts of *Leonurus cardiaca.* Quantitative phytochemical composition of cyanogenic glycoside in the aerial parts of *Leonurus cardiaca* showed seven different cyanogenic glycosides expressed in mg/100 g as shown in Table 4. 7-chloro-6-Desoxy-Haraoagide was the highest in concentration which was 44.09 mg/100 g followed by lavandulifolioside (23.77 mg/100 g), Galliridoside (18.00 mg/100 g), rutoside (17.81 mg/100 g), verbacoside (14.36 mg/100 g) and Quabain ($2.61x10^{-5}$ mg/100 g). The least in concentration was taraxacoside ($1.21x10^{-5}$ mg/100 g) while the sum total of all the cyanogenic glycoside sub-members were 118.03 mg/100 g as presented in Table 4.

Cyanogenic glycosides have amino acid–derived aglycones that are mostly a safety concern in medicinal plants. The concerns about cyanogenic glycosides are twofold. First, these compounds interfere with iodine organification and thus can cause or promote goiter and hypothyroidism if and only if it is massively consumed at level higher than from 350 ppm (350 mg)(FAO/WHO[30]. Second, cyanogenic glycosides is spontaneously degraded to release potentially lethal hydrogen cyanide once the glycosidic linkage is hydrolyzed. However, it is only when massive and rapid intake of cyanogenic glycosides occurs, the cyanide is quickly and safely detoxified by hepatic thiosulfate sulfurtransferase [33]. Dietary exposure to elevated levels of 350 mg/100g of some cyanogenic glycosides in food has the potential to cause acute cyanide poisoning or a debilitating irreversible neurological condition in the long term [33]. In this study, phytochemical composition of cyanogenic glycoside in the aerial parts of *Leonurus cardiaca* showed seven different cyanogenic glycoside expressed in mg/100 g and their total concentration was 118.03 mg/100 g (Table 4), which is far much lesser than the cynogenic glycoside content in cassava (75-350 ppm). The lower concentration of the cynogenic glycoside content in the aerial parts of *Leonurus cardiaca* is suggestive that the aerial parts of the plant on consumption as vegetable (in the Niger Delta and Easter Region of Nigeria) will not leads to potential to cause acute cyanide poisoning or a debilitating irreversible neurological condition in the long term.

Table 5 shows the qualitative and quantitative glycoside compositions of the aerial parts of *Leonurus cardiaca.* Quantitative phytochemical composition of glycoside in the aerial parts of *Leonurus cardiaca* showed thirteen (13) different glycosides expressed in mg/100 g as shown in Table 5. Digoxin was the highest in concentration which was 6.92 mg/100 g followed by digitoxin (4.25 mg/100 g), linamarin (3.96 mg/100 g), amygdalin (1.03 mg/100 g), methyl linamarin ($9.02x10^{-1}$ mg/100 g), arbutin ($7.89x10^{-6}$ mg/100 g), artemetin ($5.23x10^{-3}$ mg/100 g), salicin ($4.73x10^{-5}$ mg/100 g), prunasin ($3.88x10^{-5}$ mg/100 g) and lotaustralin ($3.77x10^{-4}$ mg/100 g). The least among them was ouabain ($1.12x10^{-3}$ mg/100 g) while the sum total of the glycoside sub-member was 16.17 mg/100 g.

Jeong et al. [34], Langenhan et al. [35], Park et al. [36] reported the anticancer activity of ouabain, digoxin, digitoxin, digitoxigenin, and lanatoside C, glycosides, which has attracted lots of attention not only due to an increase of solubility and distribution in the body. This cardenolide glycoside elicited marked cytotoxicity against human cancer cell lines, chronic myelogenous leukemia and human gastric cancer cells with IC50 values of 0.026 and 0.027 μg/mL, respectively. Sun and Colleagues

Table 4. Quantitative phytochemical composition of cyanogenic glycosides in the aerial parts of *Leonurus cardiaca*

Cyanogenic glycosides	Concentration (mg/100 g)
Galliridoside	18.00
7-chloro-6-Desoxy-Haraoagide	44.09
Rutoside	17.81
Quabain	$2.61x10^{-5}$
Taraxacoside	$1.21x10^{-5}$
Verbacoside	14.36
Lavandulifolioside	23.77
Total	118.03

Table 5. Phytochemical composition of glycosides in the aerial parts of *Leonurus cardiaca*

Glycosides	Concentration (mg/100 g)
Arbutin	$7.89x10^{-6}$
Linamarin	3.96
Salicin	$4.73x10^{-5}$
Artemetin	$5.23x10^{-3}$
Methyl Linamarin	$9.02x10^{-1}$
Amygdalin	1.03
Ouabain	$1.12x10^{-3}$
Dhurrin	$4.35x10^{-5}$
Prunasin	$3.88x10^{-5}$
Cucurbitin	$2.18x10^{-5}$
Digitoxin	4.25
Digoxin	6.92
Lotaustralin	$3.77x10^{-4}$
Total	**16.17**

[37] studied he anticancer profile of steroidal glycoside, solamargine, isolated from Solanum incanum in several cancer cells which showed marked anticancer effects in multiple cancer cells, including multiple-drug-resistant cancer cells. In this study, quabain, digitoxin, digoxin, amygdalin and arbutin which have been reported to possess and yield anticancer properties were observed to be high in concentration in the aerial parts of *Leonurus cardiaca*. The presence of these anticancer glycosides in the aerial parts of the *Leonurus cardiaca* is indicative of the anticancer activity of the plants, hence formulations form the aerial parts of the plant can be used as herbal therapy for the treatment of cancer of various types.

Table 6 shows the qualitative and quantitative anthocyanin compositions of the aerial parts of *Leonurus cardiaca.* Phytochemical composition of anthocyanins in the aerial parts of *Leonurus cardiaca* showed five (5) different anthocyanins expressed in mg/100 g (Table 6). Cyanidin-3-glucoside was the highest in concentration which was 56.53 mg/100 g followed by Caffeolated (cyaniding-3-sophoroside-5-glucoside) ($4.90x10^{-4}$ mg/100 g), p-hydroxybenzolated (Peonidin-3-sphoroside ($1.73x10^{-5}$ mg/100 g) and Peonidin-3-sophoroside-5-glycoside ($1.06x10^{-4}$ mg/100 g). The least in concentration was p-hydroxybenzolated (cyanidine-3-sophoroside ($1.04x10^{-4}$ mg/100 g) while the sum total of all the anthocyanin sub-members were 56.53 mg/100 g) (Table 6). Anthocyanins are regarded as colored water-soluble pigments that fall into the phytochemical phenolic acid member, existing as glycosylated pigments. The fine red, purple, and blue colorations observed in fruits, grapes, and vegetables are mainly due to the presence of anthocyanins in those food substances [38]. Cyanidin-3-glucoside anthocyanin member is the major anthocyanin pigment found in most of the plants and has been traditionally exploited as a natural food colorant [38].

The use of anthocyanin-based colorants in yogurt drink and some mixed fruit juice is becoming more popular [39]. Meanwhile, some food industrial companies utilize synthetic dyes in their products, which may be toxic if over-consumed and bioaccumulates. Recently, acylated anthocyanins are used as food colorants in the food industry due to their high stability over nonacylated anthocyanins [40]. Colored pigments are potent nutraceutical or pharmaceutical ingredients and anthocyanin is one of the bioactive components as nutraceutical and traditional medicine, traditionally used as a phytopharmaceutical, appetite stimulant, choleretic agent, and for treatment of many other diseases. In this study, peonidin-3-sophoroside-5-glycoside, p-hydroxybenzolated (cyanidine-3-sophoroside, caffeolated (cyaniding-3-sophoroside-5-glucoside, p-hydroxybenzolated (Peonidin-3-sphoroside, and cyanidin-3-glucoside which are powerful colorants anthocyanins [38,39,41] were observed in appreciable quantities. The presences of these phytochemical anthocyanin members in the aerial parts of *Leonurus cardiaca* is indicative that of the plant being and excellent natural source food colorants, phytopharmaceutical, and appetite stimulant. This could be the more reason it is consumed as vegetable in the Niger Delta and Eastern region as well as in Latin, where its name originated (*Leonurus cardiaca*, meaning lion's heart).

Table 6. Phytochemical composition of anthocyanins in the aerial parts of *Leonurus cardiaca*

Anthocyanins	Concentration (mg/100 g)
Peonidin-3-sophoroside-5-glycoside	$1.06x10^{-4}$
p-hydroxybenzolated (cyanidine-3-sophoroside	$1.04x10^{-4}$
Caffeolated (cyaniding-3-sophoroside-5-glucoside	$4.90x10^{-4}$
p-hydroxybenzolated (Peonidin-3-sphoroside	$1.73x10^{-5}$
Cyanidin-3-glucoside	56.53
Total	**56.53**

Table 7. Phytochemical composition of alkaloids in the aerial parts of *Leonurus cardiaca*

Alkaloids	Concentration (mg/100 g)
9-Octadecenamide	$1.13x10^{-6}$
Vicine	$1.06x10^{-6}$
Dihydro-oxo-demethoxyhaemanthamine	$1.84\ x10^{-6}$
Augustamine	$1.67\ x10^{-5}$
Oxoassoanine	$1.19\ x10^{-6}$
Sparteine	$2.16\ x10^{-6}$
Cinchonidine	$1.53\ x10^{-6}$
Cinchonine	$1.20\ x10^{-6}$
Crinane-3-alpha-ol	$3.73\ x10^{-6}$
Buphanidrine	$1.97\ x10^{-6}$
Alpha allocryptopine	$3.27\ x10^{-6}$
Indicine-N-oxide	$1.88\ x10^{-6}$
Octahydro-2H-quinolizide	$4.37\ x10^{-2}$
Tetrafydrocolumbamine	$3.25\ x10^{-6}$
Coptisine	$1.62\ x10^{-6}$
Powelline	$7.19\ x10^{-7}$
Nortupinane	$3.77\ x10^{-5}$
Lonurine	$3.74\ x10^{-1}$
6-Hydroxybuphanidrine	$2.37\ x10^{-6}$
6-Hydroxypowelline	$3.09\ x10^{-6}$
Nitidine	$1.53\ x10^{-6}$
Starchdrine	$8.93\ x10^{-1}$
Tetrahydrocoptisine	$1.30\ x10^{-5}$
Crinamidine	$1.51\ x10^{-5}$
Akuammidine	$7.35\ x10^{-5}$
Echitamidine	$9.70\ x10^{-7}$
Total	**1.31**

Table 7 shows the qualitative and quantitative alkaloid compositions of the aerial parts of *Leonurus cardiaca*. Phytochemical composition of anthocyanins in the aerial parts of *Leonurus cardiaca* showed twenty six (26) different alkaloids expressed in mg/100 g as shown in Table 7. Echitamidine was the highest in concentration which was $9.70\ x10^{-7}$ mg/100 g followed by starchdrine ($8.93\ x10^{-1}$ mg/100 g), akuammidine ($7.35\ x10^{-5}$ mg/100 g), Octahydro-2H-quinolizide ($4.37\ x10^{-2}$ mg/100 g), nortupinane ($3.77\ x10^{-5}$ mg/100 g), lonurine ($3.74\ x10^{-1}$ mg/100 g), crinane-3-alpha-ol ($3.73\ x10^{-6}$ mg/100 g), alpha allocryptopine ($3.27\ x10^{-6}$ mg/100 g), tetrafydrocolumbamine ($3.25\ x10^{-6}$ mg/100 g), 6-hydroxybuphanidrine ($2.37\ x10^{-6}$ mg/100 g), sparteine ($2.16\ x10^{-6}$ mg/100 g), buphanidrine ($1.97\ x10^{-6}$ mg/100 g), indicine-N-oxide ($1.88\ x10^{-6}$ mg/100 g), dihydro-oxo-demethoxyhaemanthamine ($1.84\ x10^{-6}$ mg/100 g), augustamine ($1.67\ x10^{-5}$ mg/100 g), coptisine ($1.62\ x10^{-6}$ mg/100 g), nitidine ($1.53\ x10^{-6}$ mg/100 g), cinchonidine ($1.53\ x10^{-6}$ mg/100 g), cinchonine ($1.20\ x10^{-6}$ mg/100 g) and 9-Octadecenamide ($1.13x10^{-6}$ mg/100 g). The least in concentration was vicine ($1.06x10^{-6}$ mg/100 g) while the sum total of all the alkaloid sub-members were 1.31 mg/100 g) as shown in Table 7.

Alkaloids have been reported to possess strong biological effects on animal and human organisms in very small doses and are present in both food and drinks. Alkaloids such as 9-Octadecenamide, tetrahydrocoptisine, and alpha allocryptopine serve as stimulant drugs and elicit anti-inflammatory, anticancer, analgesics, local anesthetic and pain relief, neuropharmacologic, antimicrobial, antifungal, and many other activities [40,42]. In this study, 9-Octadecenamide, Tetrafydrocolumbamine, alpha allocryptopine and the rest 23 alkaloid sub-members were characterized from the aerial parts of *Leonurus cardiaca* and could be responsible for the analgesic tail flicking action [43] and the immunoregulatory effect of extract of *Leonurus cardiaca* [44].

Table 8 shows the qualitative and quantitative flavonoid compositions of the aerial parts of *Leonurus cardiaca.* Phytochemical composition of flavonoids in the aerial parts of *Leonurus cardiaca* showed six (6) different flavonoids expressed in mg/100 g as shown in Table 8. Daidzein was the highest in concentration which was 3.34 mg/100 g followed by genistein (2.00 mg/100 g), coumesterol ($8.75x10^{-1}$ mg/100 g), daidzin ($6.57x10^{-2}$ mg/100 g) and 6-O-Acetyldaidzin ($4.94x10^{-3}$ mg/100 g). The least in concentration was glycitein ($4.08x10^{-1}$ mg100 g) while the sum total of the flavonoid sub-members were 7.31 mg/100 g as presented in Table 8.

Daidzein, genistein, glycitein,and daidzin are naturally occurring isoflavonic phytoestrogen belonging to the non-steroidal estrogens [45]. They are a major bioactive substance in traditional Chinese medicine Gegen [46] which elicit therapeutic effect against fever, acute dysentery, diarrhea, diabetes, cardiac dysfunctions, breast cancer [47], osteoporosis, diabetes, cardiovascular diseases, nephroprotective [48] liver injury etc, [49]. In this study, daidzein, genistein, glycitein, 6-O-Acetyldaidzin, coumesterol, and daidzin were characterized from the aerial parts of *Leonurus cardiaca.* The presence of these flavonoid sub-members in the plant is expressive that is source of several novel therapies that could used for the treatment of several illnesses including cancer, ameobi dysentery, cardiovascular disorder, diabetes mellitus, renal failure and liver damage which is in agreement with [47-49] on the therapeutic application of flavonoid sub-members against several diseases.

Table 9 shows the qualitative and quantitative sterol compositions of the aerial parts of *Leonurus cardiaca* Quantitative phytochemical composition of sterols in the aerial parts of *Leonurus cardiaca* showed seven (7) different sterol expressed in mg/100 g (Table 9). Sitosterol was the highest in concentration which was 4.50 mg/100 g followed by stigmasterol ($7.04x10^{-1}$ mg/100 g), cholestanol ($5.79x10^{-5}$ mg/100 g), campesterol ($3.71x10^{-1}$ mg/100 g), savenasterol ($3.29x10^{-1}$ mg/100 g) and cholesterol ($2.67x10^{-4}$ mg/100 g). The least in concentration was ergosterol ($1.83x10^{-3}$ mg/100 g) while the sum total of all the sterol sub-members were 5.91 mg/100 g (Table 9).

Plant sterol are biologically active molecules with multiple health applications including modulation of inflammation [50], antioxidant effect [51], antiulcer, immunomodulatory [52], antibacterial, and antifungal effects [53], wound healing promotion [54] and platelet aggregation inhibition [55]. In this study, cholesterol, cholestanol, ergosterol, campesterol, stigmasterol, savenasterol, and Sitosterol were characterized from the aerial parts of *Leonurus cardiaca* which are that the plant possess anticancer, antifungal, wound healing and antioxidant potentials.

Table 10 shows the qualitative and quantitative tannin composition of the aerial parts of *Leonurus cardiaca.* Quantitative phytochemical composition of tannin in the aerial parts of *Leonurus cardiaca* showed a total amount of 426.49 mg/100 g as (Table 10). However, Table 10 shows the qualitative

Table 8. Phytochemical composition of flavonoids in the aerial parts of *Leonurus cardiaca*

Flavonoids	Concentration (mg/100 g)
Daidzein	3.34
Coumesterol	$8.75x10^{-1}$
Genistein	2.00
Glycitein	$4.08x10^{-1}$
Daidzin	$6.57x10^{-2}$
6-O-Acetyldaidzin	$4.94x10^{-3}$
Total	**7.31**

Table 9. Quantitative Phytochemical Composition of Sterol Content in the Aerial Parts of *Leonurus cardiaca*

Sterols	Concentration (mg/100 g)
Cholesterol	$2.67x10^{-4}$
Cholestanol	$5.79x10^{-5}$
Ergosterol	$1.83x10^{-3}$
Campesterol	$3.71x10^{-1}$
Stigmasterol	$7.04x10^{-1}$
Savenasterol	$3.29x10^{-1}$
Sitosterol	4.50
Total	**5.91**

Table 10. Quantitative phytochemical composition of tannin and phytate contents in the aerial parts of *Leonurus cardiaca*

Parameter	Concentration (mg/100 g)
Tannins	426.49
Total	426.49
Phytate	69.12
Total	**69.12**

Table 11. Quantitative composition of terpenoid content in the aerial parts of *Leonurus cardiaca*

Essential Oils	Percentage (%)
Alpha pinene	10.06
Beta pinene	0.92
Benzyl alchohol	0.14
Cis-Ocimene	0.12
Myrcene	0.07
Allo ocimene	0.07
Limonene	2.26
Alpha thujene	0.06
Gama terpinene	0.15
Geijerene	0.12
Fenchone	0.14
Neral	0.09
Isoartemisia	0.06
1,8-Cineole	0.14
Geranial	0.07
Nerol	0.08
Beta caryophyllene	42.01
Linaniol	2.70
Borneol	0.12
Alpha humulene	38.88
Alpha terpineol	0.06
Terpinen-4-ol	0.06
Pregeijerene	0.06
Thymyl methyl eher	0.07
Ascaridole	0.08
Linalyl acetate	0.11
Ethyl cinnamate	0.14
Borneol acetate	0.17
Linalyl acetate	0.50
Beta bissabolene	0.11
Trans-alpha-bergamotene	0.12
Gama carinene	0.08

Essential Oils	Percentage (%)
Beta cardinene	0.03
Alpha copane	0.04
Bicyclogermacrene	0.04
Germacrene D	0.06
Safrole	0.53
Elemicin	0.03
Benzyl benzoate	0.09
Nerolidol	0.09
Total	**100.00**

and quantitative phytate composition of the aerial parts of *Leonurus cardiaca.* Quantitative phytochemical composition of phytate in the aerial parts of *Leonurus cardiaca* showed a total amount of 69.12 mg/100 g (Table 10).

Tannins are widely distributed in various plants, and they are considered defensive molecules to protect plant tissues from herbivorous attacks because of their astringent taste [55]. [56,57] reported that several natural tannins and related compounds have various biological activities, including antioxidant, antitumor, hypolipidemic, hypoglycemic, and antibacterial activities. In this study, 426.49 mg/100 g of tannins was characterized from the aerial parts of the *Leonurus cardiaca*, which shows that it can be used as a potent herbal agent in the treatment of anti-inflammatory diseases, hyperglycemic condition and microbial infections. More so, the presence of the anti-nutrients such as phytic acid in food affects nutrients absorption and bioavailability and Phytic acid (PA) amongst other anti-nutrients exhibits such properties of interfering with nutrients bioavailability [57-59]. In this study, 69.12 mg/100 g of phytic acid was characterized from the aerial parts of *Leonurus cardiaca*. This quantity of phytate in the plant might be large enough to inhibit absorption of vital minerals in the body. Also, the concentration of phytate in the plant shows the plant is a rich source of novel therapies against several illnesses aside it anti-nutritional properties.

Table 11 shows the qualitative and quantitative essential oil compositions of the aerial parts of *Leonurus cardiaca*. Quantitative phytochemical composition of essential in the aerial parts of *Leonurus cardiaca* showed fourty one (41) different essential oils expressed in percentage (%) (Table 11). Beta caryophyllene was the highest in concentration which was 42.01 (%) followed by Quantitative phytochemical composition of sterols in the aerial parts of *Leonurus cardiaca* showed Fourty one (41) different essential oils expressed in percentage (%) as shown in Table 11. Beta caryophyllene was the highest in concentration which was 42.01 (%) followed by alpha humulene (38.88%), alpha pinene (10.06 %), linaniol (2.70 %), limonene (2.26 %), beta pinene (0.92 %), safrole (0.53 %), linalyl acetate (0.50 %), borneol acetate gama (0.17 %), terpinene (0.15 %), ethyl cinnamate (0.14 %), 1,8-Cineole (0.14 %), fenchone (0.14 %), benzyl alchohol 90.14 %), trans-alpha-bergamotene (0.12 %), borneol (0.12 %), Geijerene (0.12 %), linalyl acetate (0.11 %), beta bissabolene (0.11 %), nerolidol (0.09 %), neral (0.09 %), nerol (0.08 %), ascaridole (0.08 %), gama carinene (0.08 %), myrcene (0.07 %), allo ocimene (0.07 %), alpha thujene (0.06 %), isoartemisia (0.06 %), alpha terpineol (0.06 %), terpinen-4-ol (0.06 %), pregeijerene (0.06 %), germacrene D (0.06 %), bicyclogermacrene (0.04 %) and alpha copane (0.04 %). The least in percentage was beta cardinene (0.03 %) while the sum total of all the essential oil sub-members were 100. 00 % (Table 11).

Essential oils one of the natural medicament currently studied and applied in the treatment of bacterial diseases [59] and there over 3000 known essential oils characterized from the leaf and aerial parts of medicinal plants [60-62]. Alpha and beta pinenes, cis-Ocimene, and allo ocimene have been reported to produce antimicrobial [63], anticoagulative/antiplatelet [63], anti-inflammatory, anti-tumor [64-66], gastroprotective [67-69], neuroprotective [70,71], cytoprotective [71] activities. In this study, alpha pinenes, beta pinenes, cis-Ocimene, and allo ocimene were among the essential oil characterized from the aerial parts of *Leonurus cardiaca*, indicating the aerial parts of the plant is natural source of medicaments that elicit the pharmacological activities mentioned above [63-66,70,71].

[72] demonstrated that benzyl alcohol, benzoic acid and its salts (ie, sodium, calcium, magnesium, and potassium benzoate), and benzyl benzoate are important fragrance

ingredients, pesticides, pH adjusters, preservatives, solvents, and/or viscosity decreasing agents in cosmetic products. Essential oils of various sub-members possess antifungal activity of the essential oil was also evaluated against economically important foliar and soil-borne fungal pathogens of tomato. The essential oil was active against *Sclerotinia sclerotiorum*, *Botrytis cinerea*, *Phytophthora infestans*, and *Verticillim dahliae* [24,73-75]. In this study, the linaniol, borneol acetate gama, terpinene, ethyl cinnamate, alpha humulene, 1,8-Cineole, fenchone, trans-alpha-bergamotene, borneol, geijerene, linalyl acetate, beta bissabolene, nerolidol, neral, nerol, alpha thujene, isoartemisia, alpha terpineol, ascaridole, gama carinene, myrcene, allo ocimene, alpha terpineol, terpinen-4-ol, pregeijerene, germacrene, bicyclogermacrene, and alpha copane were quantified from the aerial parts of *Leonurus cardiaca*. The numerous essential oils discovered in the plants including other phytochemical constituents shown in Table 1-10, defined the wide application of herbal formulation of the plant as therapies against divers diseases. Herbal therapies that can be design from *Leonurus cardiaca* will help to circumvent the challenges pose by current antibacterial agents used for the treatment of oral health problems which are reported to cause several side effects such as diarrhea, vomiting, etc., [76-79].

4. CONCLUSION

The curative desirability of medicinal plants reside in chemical structure that give rise to a definitive physiological action on the human body while the ultimate predominant of these bioactive ingredients of plants are alkaloids, tannins, flavonoids, and phenolic compounds. Our uncovering indicated *Leonurus cardiaca* is an excellent source of terpenoids, saponins, alkaloids, anthraquinones, anthocyanins, phenolic acid, sterols, cyanogenic glycoside, phytate, tannins, glycosides, flavonoids, and essential oils. This present research exemplify the preparatory detection for discretion or selection of *Leonurus cardiaca* potential source of novel therapies for the treatment of various diseases.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

NOTE

This study highlighted the effectiveness of “traditional medicine” which is an ancient tradition practiced in some parts of India. This ancient concept should be carefully investigated in the light of modern clinical science and can be adopted partially if considered appropriate.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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