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Comparative Studies on the Phytochemical Properties of Five Nigerian Medicinal Plants

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors designed the study and wrote the protocol. Author CE collected the samples, processed it and performed the phytochemical analysis. Author JCI managed the literature searches, interpreted the results and wrote part of the manuscript. Author CE performed the statistical analysis and formatted the final manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: This work investigated the phytochemical composition of five Nigerian medicinal plants and the significance of the phytochemicals with respect to the treatment of diseases were discussed.
Study Design: Fifteen phytochemicals were qualitatively analysed from the plants ethanolic extracts while five out of these were quantitatively determined.
Place and Duration of Study: Department of Biochemistry, Chukwuemeka Odumegwu Ojukwu University, Uli, Nigeria, between July, 2014 and August, 2014.
Methodology: Standard phytochemical analysis methods were adopted.
Results: Preliminary screening of the leaves of *Psidium guajava*, *Azadirachta indica*, *Carica papaya*, the rhizomes of *Zingiber officinale* and bulbs (cloves) of *Allium sativum* revealed the

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presence of alkaloids, tannins, flavonoids, saponins, phenols, steroids, terpenoids and carboxylic acids in all the plants ethanolic extracts. *A. indica* contained all the phytochemicals except coumarin, while there was the absence of anthraquinone, phlobatannin, and quinone in *A. sativum*. Phlobatannins was also absent in *C. papaya* and *P. guajava* extracts. There was also the absence of anthraquinone and cardiac glycosides in *P. guajava* and *Z. officinale* respectively. Resins were not detected in the plants extracts of *C. papaya* and *Z. officinale*. The quantitative analysis of the five selected phytochemicals revealed that there was significant difference in the mean values of alkaloids and flavonoids contents of the plants at $P<0.05$. *P. guajava* however, had the highest alkaloids content (1.90±0.02%) while *A. sativum* had the highest flavonoids content (4.20±0.02%). *A. indica* contained the highest phenols and tannins, (0.36±0.01%) and (2.63±0.01%) respectively. Saponins was found highest in *A. sativum* (2.60±0.02%).

Conclusion: The results justified the medicinal potentials of these plants in the treatment of diseases.

Keywords: Nigerian medicinal plants; phytochemicals; quinines; anti-oxidants; diseases.

1. INTRODUCTION

In Nigeria and indeed most part of Africa, medicinal plants had found wide range of usage in the treatment of various diseases. These plants had been in use since time immemorial either solely or in combination with other plants in the traditional medical settings. Some of the medicinal uses of these plants had long been established and known by people especially to those who are in the interior villages with poor medical facilities. The mechanism to which these plants acts is unknown to a lay man but are generally based on the phytochemical compositions of these plants. Some plants have a peculiar phytochemical which in combination with other phytochemical(s) synergistically trigger metabolic responses. Recently, scientists have found evidences that specific combinations of phytochemicals are more effective in protecting against diseases than the isolated compounds, pointing to a need to study the synergy among active compounds in plants [1]. For instance, extracts from the leaves of guava, lime orange, dogonyaro and garlic optional are taken as worm expeller in which adult are administered a glass full 2 times daily while kids (5 years and above) are given spoonful (5 ml) 2 times daily [2].

Phytochemicals simply refers to chemicals that are found in plants. It is a term that are broadly used to describe chemical constituents of plants which differ from the normal nutrients. These phytochemicals work in a number of ways which differ from one another depending on the functional group present in the chemical. Some are effective as free radical scavengers while some have anti-bacterial, anti-viral, anti-fungal, anti-inflammatory activity (Table 1). Notably among these phytochemicals are phenolic compounds flavonoids, alkaloids, tannins, saponins, cardiac glycosides, steroids, quinones, terpenoids and so on with further sub-classes.

Zingiber officinale (ginger) is a perennial herbaceous plant which belongs to the family Zingibiraceae. It has a thick underground stem (rhizome) that extends above the ground. The rhizome in dried form are used in various condiments in the preparation of food and medicine and are notable for its pleasant taste and smell. *Allium sativum* commonly referred to as garlic is a very popular specie of the onion family. The plant is always remembered for its foul smell especially when cut. Garlic is a powerful and indispensable medicinal plant that cannot be wished away in any herbal home. It has been implicated in the treatment of various diseases [3]. *Psidium guajava* known as guava is a perennial tree having a thick stem branches and produces sweet edible fruits. It thrives well in the rainforest zone. The leaves and bark have long history of medicinal uses. Lozoya et al. [4] reported that more than 20 compounds had been isolated from the leaves of guava with quercetin as the main active substance.

Carica papaya referred to as pawpaw, is a perennial herbaceous plant with succulent tissues. It thrives well in area with moderate to heavy rainfall. Its fruit is loved by many and widely consumed in ripped and unripe form. Medicinally, the use of different parts of the plant had been reported [5]. *Azadirachta indica* referred to as neem and locally known as dogonyaro in the northern part of Nigeria is a perennial tree plant with the ability to survive different climatic condition ranging from areas with little rainfall and heavy rainfall. Neem leaves, had been used for the treatment of many diseases ranging from skin diseases, microbial infections and numerous others (Table 1).

However, the leaves of *P. guajava*, *A. indica*, *C. papaya*, the rhizomes of *Z. officinale* and bulbs/cloves of *A. sativum* were selected for these studies based on their popular and random use in the treatment of various diseases by people living in remote areas in Nigeria. Qualitative and quantitative studies would be carried out on them and results obtained would be discussed in relation of its use in the treatment of diseases.

2. MATERIALS AND METHODS

2.1 Sample Collection

Fresh leaves of *A. indica*, *C. papaya* and *P. guajava* were obtained around Uli campus while the bulbs/cloves of *A. Sativum* and rhizomes of *Z. officinale* were purchased from the local market in the school front of Uli campus. The plants obtained were identified and authenticated from standard resources. The collected sample were dried in shade, crushed to coarse powder and stored appropriately for further studies.

2.2 Preparation of Ethanolic Extract

The crude ethanolic extract was prepared using 95% ethanol by weighing 100 g of powdered sample, then mixed with 500 ml of 80% ethanol. The mixture was incubated at 25℃ with constant shaking at 150 rpm for three days in orbital shaker (Stuart Orbital Shaker SSL1). After constant shaking at 150 rpm for three days, the sample was filtered using Whatman filter paper. Filtrate was incubated at 40℃ till all the solvent was evaporated leaving behind the crude ethanolic extracts.

2.3 Methods for Qualitative Analysis

Phytochemical screening for flavonoids, saponins, phenols, alkaloids and carbohydrates were performed by the method of Prashant et al. [18]. Phlobatannins, anthraquinones, steroids, terpenoids, and cardiac glycosides were by Trease and Evans [19], Sofowora [20], Harborne and Harborne [21], Kokate [22], Kaur and Arora [23], and Kumar et al. [24]. Tannins, coumarin, quinone, carboxylic acid, resins were by the method of Salna et al. [25] and Saidulu et al. [26].

2.4 Method for Quantitative Analysis

2.4.1 Determination of flavonoids

Ten grams of the plant sample was extracted with 100 ml of 80% aqueous methanol at room temperature and allow to stand for 5 to 10 minutes. The whole solution was filtered through Whatman filter paper No 42 (125 mm). The filtrate was later transferred into a crucible and evaporated to dryness and weighed to a constant weight. The percentage flavonoids was calculated by difference [27].

2.4.2 Determination of alkaloids

Five grams of the plant sample was placed in a 250 ml beaker and 200 ml of 10% acetic acid in ethanol added. The mixture was covered and allowed to stand for 4 hours at 25ºC. It was then filtered with filter paper No. 42 and the filtrate was concentrated on a water bath until it reaches a quarter of its original volume. Concentrated NH_4OH was added drop wise until precipitation was complete. The mixture was allowed to settle and the precipitate collected on a pre-weighed filter paper and washed with dilute NH_4OH. The precipitate, alkaloid, was dried and weighed. The percentage alkaloid was calculated by difference [28,29].

2.4.3 Determination of total saponins

The method used was that of Obadoni and Ochuko [29]. The samples were ground and 20 g of each were put into a conical flask and 100 ml of 20% aqueous ethanol were added. The samples were heated over a hot water bath for 4 h with continuous stirring at about 55℃. The mixture was filtered and the residue re-extracted with another 200 ml 20% ethanol. The combined extracts were reduced to 40 ml over water bath at about 90℃. The concentrate was transferred into a 250 ml separatory funnel and 20 ml of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated. Then 60 ml of n-butanol was added. The combined n-butanol extracts were washed twice with 10 ml of 5% aqueous sodium chloride. The remaining solution was heated in a waterbath. After evaporation the samples were dried in the oven to a constant weight; the saponin content was calculated as percentage.

2.4.4 Determination of total tannin by titration

The Follin Denis titrating method as described by Pearson [30] was used. To 20 g of the crushed sample in a sample conical flask was added 100 ml of petroleum ether and covered for 24 hours. The sample was then filtered and allowed to stand for 15 minutes allowing petroleum ether to

evaporate. It was then re-extracted by soaking in 100 ml of 10 % acetic acid in ethanol for 4 hours. The sample was then filtered and the filtrate collected. About 25 ml of NH_4OH were added to the filtrate to precipitate the alkaloids. The alkaloid were heated with electric hot plate to remove some of the NH_4OH still in solution. The remaining volume was measured to be 33 ml and 5 ml of this was taken and 20 ml of ethanol added to it. It was titrated with 0.1 M NaOH using phenolphthalein as indicator until a pink end point was reached. Tannin content was then calculated.

2.4.5 Determination of total phenols

The fat free sample was boiled with 50 ml of ether for the extraction of the phenolic component for 15 min. Five ml of the extract was pipetted into a 50 ml flask, then 10 ml of distilled water was added. Two ml of ammonium hydroxide solution and 5 ml of concentrated amylalcohol were also added. The samples were made up to mark and left to react for 30 min for colour development. This was measured at 505 nm [27].

2.5 Statistical Analysis

The experimental data were analysed for statistical significance by one-way analysis of variance (ANOVA) using the IBM-SPSS computer-based programme version 20. Least significance difference (LSD) was determined at 95% level of significance ($P<0.05$). All data were expressed as mean ± standard deviation.

3. RESULTS AND DISCUSSION

3.1 Results

The results for the qualitative and quantitative phytochemical analysis of the leaves of *A. indica, C. papaya, P. guajava*, cloves of *A. sativum* and the rhizomes of *Z. officinale* were respectively presented in (Table 2 and 3). The qualitative analysis revealed the presence of alkaloids, tannins, flavonoids, saponins, phenols, steroids, terpenoids, carboxylic acids and carbohydrates in all the plants extracts. Cardiac glycosides and coumarin were absent in *Z. officinale* and *A. indica* respectively. Anthraquinone was absent in *A. sativum* and *P. guajava* which was consistent with the findings of Adeyemi et al. [14] and Harsha et al. [31]. Phlobatannins was absent in *A. sativum, C. papaya,* and *P. guajava*. The absence of phlobatannins in *C. papaya* was contrary to the report of Njoku and Obi [10]. Resins was absent in *C. papaya* while quinone was absent in *A. sativum* and *Z. officinale* extract. The presence of some of these phytochemicals in the extracts justified their medicinal uses. Each phytochemical analysed were discussed further.

Quantitative phytochemical studies on the five selected phytochemicals on the leaves of *A. indica, C. papaya, P. guajava,* bulbs/cloves of *A. sativum* and the rhizomes of *Z. officinale* (Table 3) revealed varying percentage concentrations of the phytochemicals at $P<0.05$. Findings were explicitly discussed.

3.2 Discussion

The presence of different types of phytochemicals in the various plant samples suggest that the plant would have pharmacological properties. Phytochemicals are known to differ from each other depending on their chemical make-up. Differences in their chemical make-up signifies that they would have different metabolic actions. These phytochemicals were discussed explicitly in relation to the treatment of diseases.

3.2.1 Quinones

The presence of quinone in the ethanolic extracts of the leaves of *A. indica, C. papaya* and *P. guajava* is of great importance. This is because quinones is an important agent which undergo highly regulated redox reaction while bound to specific sites in integral membrane proteins in the electron transport chain [32]. Quinone had been of interest to research biochemists having been implicated in a number of metabolic diseases. However, depending on the particular system, quinones can act as anti-oxidants and protect healthy cells against reactive oxygen species (ROS), or act as cytotoxic agents, generating ROS in unhealthy cancer cells when induced [32]. However, Madeo et al. [32] reported that redox reactions mediated by benzoquinones are the source of potentially cytotoxic ROS including superoxide, hydrogen peroxide, and the hydroxyl radical. Quinone mediated ROS can cause cellular damage through alkylation reactions with lipids, proteins, and DNA [33]. Depending on the oxidative state of the kidney, quinones can be nephrotoxic or nephro-protective [32]. Notably is the fact that quinone is different from quinine (an alkaloid). Also, Prashant et al. [18] reported that quinones exhibits antimicrobial activities and works by

binding to adhesins, complex with cell walls and inactivates enzymes.

3.2.2 Anthraquinones

Anthraquinones are aromatic organic compound each of which can be viewed as a quinone derivative. Anthraquinones glycosides are generally orange, red, or brown-red compounds found in fairly limited distribution within the plant kingdom. Their solubility is similar to that of other glycosides with hydrophobic aglycones. Anthraquinones are effective as antifungal, inhibition of excessive renal tubular cell proliferation, delay in deterioration of patients in renal failure and modulation of inflammation by partially inhibiting cyclooxygenase [34]. As far as is known, subcathartic doses or doses of noncathartic forms of herbs containing anthraquinone glycosides do not cause any serious adverse effects [34]. The aglycones can discolour the urine and faeces red, brown, or black as they are excreted. They function as laxatives which could account for *C. papaya* laxative properties (Table 1). They are also anti-malarial, anti-plastic used in the treatment of cancer [35]. Use of anthraquinone glycosides for longer than 10 days consecutively can readily lead to induction of atonic constipation as the colon adapts to the cathartic impulses. Persistent use or abuse can also lead to diarrhoea with fluid and electrolyte loss and, ultimately, rhabdomyolysis, renal failure, and other severe outcomes [34].

3.2.3 Cardiac glycosides

The presence of cardiac glycosides in the ethanolic extracts of the plants could account for their cardioactive properties (Table 1). Cardiac glycosides are used in treatment of congestive heart failure and cardiac arrhythmia, whereby they inhibit Na+/K+-ATPase pump that causes positive ionotropic effects and electrophysiological changes [36,27]. This strengthens heart muscle and the power of systolic concentration against congestive heart failure. They are also used in treatment of atrial fibrillation, flatter, and they acts as emetics and as diuretics [28,37,38]. The absence of cardiac glycosides from the screening test of *Z. officinale* contradicts the facts in Table 1 that *Z. officinale* possesses anti-emetic property although another phytochemical might be responsible for that.

3.2.4 Steroids

The presence of steroids in all the ethanolic extracts especially in *A. sativum* is an indication that they would be beneficial in solving sexual related problems. Phytosteroids are used to treat venereal diseases, and in pregnancy to ensure an easy delivery and hormonal balance as well as to promote fertility in women and libido in men [36]. They also act as starting material in the synthesis of sex hormones [39,40] and hence they are potential source of contraceptives [36]. They are also anti-microbial, analgesic, anti-inflammatory, and immuno-suppressive by inhibiting macrophage activation, blocking the production of pro-inflammatory cytokines [36]. They are also active in managing stomach ailments by enhancing intestinal absorption of Na^+ and water and in decreasing serum cholesterol levels [41,18].

3.2.5 Terpenoids

The detection of terpenoids in *A. indica* is consistent with the report that it is a source of terpenoid, which plays an important role in wound and scar healing [6]. It was observed from clinical studies, that terpenoids strengthen the skin, increase the concentration of antioxidants in wounds, and restore inflamed tissues by increasing blood supply [9]. The presence of terpenoids in *A. sativum* would account for its wound healing potentials. Also, *A. indica* is a source of pesticide and insecticide many thanks to the bioactive component azadirachtin, a type of terpenoid or more specifically a highly oxidized tetranortriterpenoid [9]. Krishnaiah et al. [9] also reported that in India it has been an age-old practice to mix dried neem leaves with grains meant for storage for protection against insect pests. Azadirachtin however is a natural insecticide and acts mainly as an anti-feedant and growth disruptor, and possesses considerable toxicity toward insects [42]. Generally, terpenoids exert their roles as antibacteria, anti-amoebic, anti-fungi, anti-viral, anti-protozoan, anti-allergens, as immune boosters and as anti-neoplasia [43,36].

3.2.6 Phlobatannins

Phlobatannins is a tannin which with hot dilute acids yields a phlobaphene. The presence of phlobatannins in the ethanolic extracts of *A. indica* and *Z. officinale* suggests anti-diuretic property of the plants [38]. Phlobatannins and tannins were also reported to be effective in the treatment of burns [44]. This is in line with the wound healing potentials of *A. indica* as presented in Table 1.

Table 1. Scientific classification and medicinal uses of *A. indica, A. sativum, C. papaya, P. guajava* and *Z. officinale*

Plant species	Scientific classification	Common name	Part under investigation	Medicinal uses	References
Azadirachta indica	Kingdom: Plantae Division: Magnoliophyta Class: Magnoliopsida Order: Sapindales Family: Meliaceae	Neem	Leaves	Anti-inflammatory, anti-diabetic, anti-microbial, anti-cancer, hepatoprotective, anti-oxidant, blood purifier/cleanser, anti-malaria, treatment of skin diseases, wound and scar healing, treatment of chickenpox, removal of hair lice, hyperglycaemia.	[6,7,8,9]
Allium sativum	Kingdom: Plantae Division: Magnoliophyta Class: Liliopsida Order: Asparagales Family: Amaryllidaceae	Garlic	Bulbs (cloves)	Anti-microbial, anti-diabetic, anti-cancer, anti-arthrosclerosis, wound healing potential, immunomodulatory, hepatoprotective, anti-oxidant, anti-helmintic, anti-coagulant, anti-hypertensive, anti-fungal, anti-inflammatory, anti-viral, blood thinner.	[10,11,3]
Carica papaya	Kingdom: Plantae Division: Magnoliophyta Class: Magnoliopsida Order: Brassicales Family: Caricaceae	Pawpaw	Leaves	Anti-bacterial, anti-inflammatory, anti-fungal, anti-cancer, acne-remedy, anti-oxidant, prevent cataract, immune booster, anti-ageing, reduction of prostrate, appetite enhancer, good laxative, reduction of menstrual pain, increment of platelet count, anti-malaria, cardioactive, treatment of jaundice, typhoid, obesity, ulcer, impotence, asthma, constipation.	[5,12]
Psidium guajava	Kingdom: Plantae Division: Magnoliophyta Class: Magnoliopsida Order: Myrtales Family: Myrtaceae	Guava	Leaves	Antimicrobial, hepatoprotective, antioxidant, anti-allergy, cardioactive, anti-diabetic, anti-mutagenic, trypanocidal activity, anti-cancer, anti-diarrhoeal, wound healing, pain relief, reducing pain, anti-hypertension, treatment of sore throat, cough, toothache, malaria,ulcers, menstrual bleeding, improvement of sperm count, dysentery, stomache upset, vertigo.	[13,14]
Zingiber officinale	Kingdom: Plantae Division: Magnoliophyta Class: Liliopsida Order: Zingibarales Family: Zingibaraceae	Ginger	Rhizomes	Anti-viral, anti-motion, anti-nausant, anti-tumor, anti-emetic, remedy of arthritis, anti-oxidant, treatment of digestive disorders, immune booster, treatment of migraine headache, protection of nerve cells, anti-alzheimer's disease, lowers blood glucose level, sore throat, treatment of hypertension, anti-pyretic, improvement of blood circulation, diaphoretic, anti-inflammatory, pain killer, anti-microbial, analgesic effects due to morphine alkaloids.	[15,16,17]

Table 2. Phytochemical constituents of *A. indica, A. Sativum, C. papaya, P. guajava* and *Z. officinale*

Phytochemicals	*A. indica*	*A. Sativum*	*C. papaya*	*P. guajava*	*Z. officinale*
Flavonoids	+	++	+	+++	++
Alkaloids	++	+	+	+	++
Saponins	+	+++	+	++	++
Tannins	+++	++	+	++	+
Phenols	+	+	+	++	+
Cardiac glycosides	+	+	+	+	-
Anthraquinones	+	-	+	-	+
Coumarins	-	+	+	+	++
Terpenoids	+	++	+	+	+
Steroids	+	++	+	+	+
Phlobatannins	+	-	-	-	+
Resins	++	+	-	++	-
Quinones	+++	-	++	++	-
Carboxylic acids	+	++	+	+	+
Carbohydrates	+	++	+	+	+

+++ = Highly present; ++ = Moderately present; + = Slightly present; - = absent

Table 3. Quantitative composition of *A. indica*, *A. sativum*, *C. papaya*, *P. guajava* and *Z. officinale*

Phytochemicals	*A. indica*	*A. Sativum*	*C. papaya*	*P. guajava*	*Z. officinale*
Flavonoids (%)	1.75 ± 0.01^{b}	1.00 ± 0.01^{e}	1.60 ± 0.02^{c}	1.90 ± 0.02^{a}	1.40 ± 0.01^{d}
Alkaloids (%)	0.71 ± 0.03^{d}	4.20 ± 0.02^{a}	1.00 ± 0.01^{c}	0.62 ± 0.01^{e}	1.60 ± 0.02^{b}
Saponins (%)	0.36 ± 0.01^{a}	0.13 ± 0.02^{c}	0.12 ± 0.00^{c}	0.21 ± 0.01^{b}	0.08 ± 0.03^{c}
Tannins (%)	1.02 ± 0.01^{c}	2.60 ± 0.02^{a}	1.56 ± 0.01^{b}	0.12 ± 0.00^{d}	1.04 ± 0.03^{c}
Phenols (%)	2.63 ± 0.01^{a}	1.23 ± 0.03^{d}	1.48 ± 0.02^{b}	1.30 ± 0.01^{c}	2.60 ± 0.02^{a}

Values were presented as Mean ± Standard Deviation of three Determinations. Mean difference within a row followed by different superscript letters are statistically significant by LSD (Least Significance Difference) test at $p < 0.05$

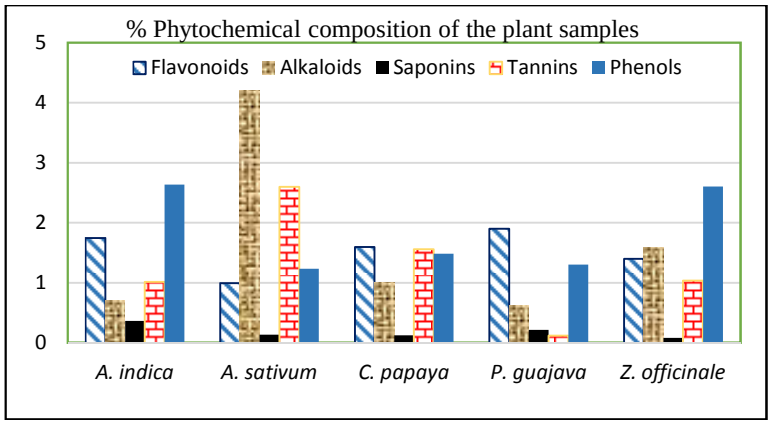

Fig. 1. The % phytochemical compositions of *A. indica*, *A. sativum*, *C. papaya*, *P. guajava* and *Z. officinale*

3.2.7 Resins

The resin produced by most plants is a viscous liquid, composed mainly of terpenes, with lesser components of dissolved non-volatile solids, which make resin thick and sticky. Its constituent, terpenes have been reported to be active against bacteria [45]. From the ethanolic extracts, resins was moderately found in *A. indica* and *P. guajava* extracts but slightly present in *A. sativum*. The result suggests that the gummy nature of stems of *A. indica* and *P. guajava* in the

use as chewing stick/brushing of teeth could be as a result of the presence of resins.

3.2.8 Coumarins

Coumarin is a phenolic compound of cinnamic acid derivative. It is used in the treatment of asthma [46] and lymphedema [47]. At high concentrations they are hepato-nephrotoxic which in acute state might degenerate to cancer of the liver. It is important to note that coumarin offer 40% protection against snake venom and occurs often in considerable amounts in anti-snake venom plants [48]. Coumarin has appetite-suppressing properties, which may discourage animals from eating plants which contained it. Though the compound has a pleasant sweet odor, it has a bitter taste, and animals tends to avoid it [49]. Coumarin has blood-thinning, anti-fungicidal and anti-tumor activities [50]. They also exhibit antiviral activities and works by interacting with eukaryotic DNA [18]. The presence of coumarin in the various plants extracts except in *A. indica* attests to their medicinal potentials. Coumarin should not be taken while using anticoagulants. Coumarin increases the blood flow in the veins and decreases capillary permeability. Coumarin is found in several plants, including tonka beans, lavender, licorice, strawberries, apricots, cherries, cinnamon, and sweet clover [50]

3.2.9 Carbohydrates

Carbohydrates can be classified in different ways based on its biological functions. They constitute the main components of the cell wall, protoplasm and cell-sap while others accumulate as insoluble storage products. The presence of carbohydrate in all the leaves, bulbs and rhizomes of the plants extracts is a clear indication that carbohydrate is ubiquitous, hence no life could exist without carbohydrate.

3.2.10 Carboxylic acids

Carboxylic acids was found present in all the ethanolic extracts. Carboxylic acid could best be described as a functional group of organic acids. Therefore its presence suggests the existence of one or more organic acids in the plant extracts. Organic acids are known to have antimicrobial effects amongst other functions.

3.2.11 Flavonoids

Flavonoids was highest in *P. guajava* (1.90±0.02%) followed by *A. indica* (1.75±0.01%) (Fig. 1). The presence of flavonoids (Table 3) would account in parts or in full the anti-oxidant and anti-microbial effects of the plants. This is because flavonoids have been reported to exert multiple biological property including antimicrobial, cytotoxicity, anti-inflammatory, anti-oxidant as well as antitumor activities [51]. Prashant et al. [18] stated that flavonoids antimicrobial activities is owed to the fact that they complex with cell wall and binds to adhesins. They also stated that flavonoids exhibits anti-diarrhoeal activities by stimulating the normalization of the deranged water transport across the mucosal cells. Flavonoids also inhibits gastrointestinal release of acetylcholine, autocoids, prostaglandins and inhibition of the contractions caused by spasmogens [18]. Mamta et al. [51] also stated that flavonoids constitute a wide range of substances that play important role in protecting biological systems against the harmful effects of oxidative processes on macromolecules such as carbohydrates, proteins, lipids and DNA. Flavonoids anti-oxidant properties had been compared with vitamin C and found to be more effective.

3.2.12 Alkaloids

Alkaloids are important phytochemical with numerous sub-class, accommodating the world's most effective chemical compounds with great biological importance. Alkaloids are significant for the protection and survival of plant because they ensure their survival against micro-organisms (antibacterial and antifungal activities) [51]. Alkaloids are known to have a powerful effect on animal physiology and play some metabolic roles and control development in living systems [51]. It is also employed in high blood pressure as it dilates the blood-vessels. It is best administered in powders or sachets [52]. Alkaloids have many pharmacological activities including antihypertensive effects (many indole alkaloids), antiarrhythmic effect (quinidine, spareien), antimalarial activity (quinine), and anticancer actions (dimeric indoles, vincristine, vinblastine) [51]. Some alkaloids have stimulant property as caffeine, nicotine and morphine are used as the analgesic and quinine as the antimalarial drug [53]. Alkaloids was however highest in *A. sativum* (4.20±0.02%) followed by *Z. officinale* (1.60±0.02%) (Fig. 1) which accounts for the medicinal properties of these plants.

3.2.13 Saponins

Saponins was found to be highest in *A. indica* (0.36±0.01%) (Fig. 1), this justifies the use of

A. indica to treat hyperglycaemia [54]. The presence of saponins in *A. indica* is another reason why the leaves were used traditionally to cleanse and purify blood [55]. Saponins also help reduce blood pressure and cholesterol level in blood. Results from statistical analysis (*P<0.05*) revealed that there is no statistical difference in means of *A. sativum* (0.13±0.02%), *C. papaya* (0.12±0.00%) and *Z. officinale* (0.08±0.03%) (Table 3). This implies that these plants may possess similar saponific effects. The presence of saponins in *A. sativum* and *Z. officinale* is the reason why it is used to treat hypertension. This is because saponins prevent the excessive intestinal absorption of cholesterol and thus reduce the risk of cardiovascular diseases such as hypertension [9]. Saponins functions also as vaccine adjuvant, as anti-inflammatory, emetics, anti-viral, antifungal, insecticidal, anti-bacterial agent by inhibiting colonization and boosting the immunity [36]. The mechanism of action for the anti-bacterial effects may involve membranolytic properties of the saponins as well as lowering of the surface tension of the extracellular medium [56]. Saponins no doubt performs inexhaustible metabolic functions.

3.2.14 Tannins and phenols

The highest concentrations of tannins and phenols was found in *A. sativum* (2.60±0.02%) and *A. indica* (2.63±0.01%) respectively. There are no significance difference in phenol concentration of *A. indica* and *Z. officinale* (2.60±0.02%). Both tannins and phenolics have endocrine role, and they function by interacting with estrogen receptors [40]. They are also anti-inflammatory, molluscicidal and hence important in the control of schistosomiasis [40]. They also have anti-diarrheal, anti-dysentery, anti-septic, anti-viral, anti-fungal, anti-parasitic, anti-irritant properties and useful in curbing haemorrhage, in wound healing, and improving vascular health by suppressing peptides that harden arteries [40,38]. Tannins antimicrobial activities could be by metal deposition/complexation, hydrogen bonding or specific interactions with vital proteins such as enzymes in microbial cells [57]. Current research has shown that polyphenols contribute to the prevention of cardiovascular diseases, cancers and osteoporosis [58,59,60].

4. CONCLUSION

Phytochemical studies on the plants extracts revealed and justified the local use of the plants in the treatment of diseases. This could be attributed to the vast occurrence of phytochemicals in these plants. However, we recommend that simpler ways for clinical isolation of this chemical components be developed for use in the traditional medical settings.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors declare that there are no competing interests.

REFERENCES

1. De Kok TM, Van Breda SG, Manson MM. Mechanisms of combined action of different chemopreventive dietary compounds: A review. Eur. J. Nutr. 2008;47(2):51-59.
2. Ezra SA. Alternative medicine-herbs clinic. J.O. Peculiar publishing home, Ogaga Street Junction, Opp JJC. Effurun, Warri, Delta State, Nigeria. 2011;4-15.
3. Gebraselema G, Mebrahtu, G. Medicinal values of garlic: A review. Intl. J. Med. and Med. Sci. 2013;5(9):401-408.
4. Lozoya X, Reyes-Morales H, Chavez-Soto MA, Martinez M, Soto-Gonzalez Y, Doubova SV. Intestinal anti-spasmodic effect of a phytodrug of *Psidium guajava* folia in the treatment of acute diarrheic disease. J. Ethanopharmacol. 2002; 83(1-2):19-24.
5. Ayoola PB, Adeyeyi A. Phytochemical and nutritional evaluation of *Carica papaya* (pawpaw) leaves. IJRRAS. 2010;5(3): 325-328.

6. Hawkins EB, Ehrlich SD. Gotu Kola. University of Maryland Medical Center. Baltimore. USA; 2006
7. Conrick J. Neem: The miraculous healing herb. Beverly Hills: America Inc. USA; 2007.
8. Atangwo IJ, Ebong PE, Eyong EU, Williams IO, Eteng MU, Egbung GE. Comparative chemical composition of leaves of some anti-diabetic medicinal plants: *Azadirachta indica*, vernonia amygdalina and gongroneme latifolium. Afri. J. Biotech. 2009;8(18):4685-4689.
9. Krishnaiah D, Devi T, Bono A, Sarbatly R. Studies on phytochemical constituents of six Malaysian medicinal plants. Journal of Medicinal Plants Research. 2009;3(2):67-72.
10. Njoku OV, Obi C. Phytochemical constituents of some selected medicinal plants. African Journal of Pure and Applied Chemistry. 2009;3(11):228-233.
11. Londhe VP, Gavasane AT, Nipati SS, Bandawane DD, Chaudhari PD. Role of garlic (*Allium sativum*) in various diseases: An overview. J. of Pharm Res. And Opinion. 2011;129-134.
12. Paul H. Is uses of papaya leaves-a powerful cure for cancer?; 2013.
13. Gutierrez RMP, Mitchell S, Soli RV. *Psidium guajava*: A review of its traditional uses, phytochemistry and pharmacology. J. Ethanopharmacol. 2008;117:1-27.
14. Adeyemi OS, Akanji MA, Oguntoye SA. Ethanolic chemical and trypanocidal activity in rats infected with trypanosome brucei. Journal of Medicinal Plant Research. 2009;3(5):420-423.
15. Samir M, Amrit PS. Medicina properties of ginger (*Zingiber officinale*). Natural Product Radiance. 2003;2(6):296-301.
16. Arnando GS. Ginger-herbal safety; 2005. Available:www.herbalsafety.utep.edu
17. Umeh SO, Emelugo BN, Bassey EE, Nwobi SC, Achufusi JN. Investigation of the anti-microbial and analgesic activities of crude ethanolic extracts of ginger (*Zingiber officinale*) rhizome. Intl. Journal of Agric. Biosci. 2013;2(3):132-135.
18. Prashant T, Bimlesh K, Mandeep K, Gurprect K, Harleen, K. Phytochemical screening and extraction: A review. Internationale Pharmaceutica Sciencia. 2011;1(1):98-106.
19. Trease GE. Evans WC. Pharmacognosy. 11th Ed. Brailliar Tiridel and Macmillian Publishers, London; 2002.
20. Sofowora A. Medicinal plants and traditional medicine in Africa. John Wiley and Son Ltd. 1993;150-153.
21. Harborne JB. Harborne AJ. Phytochemical methods: A guide to modern techniques of plant analysis. Kluwer Academic Publishers, London, UK; 1998.
22. Kokate CK. Practical pharmacognosy. Vallabh Prakashan. 2001;218.
23. Kaur GJ, Arora DS. Antibacterial and phytochemical screening of *Anethum graveolens*, *Foeniculum vulgare* and *Trachyspermum ammi*. BMC Complement. Altern Med, 2009;9:30.
24. Kumar KA, Narayani M, Subanthini A, Jayakumar M. Antimicrobial activity and phytochemical analysis of citrus fruit peels utilization of fruit waste. Int J Environ Sci Tech. 2011;3:5415-5421.
25. Salna KP, Sreejith K, Uthiralingam M, Mithu AP, John MMC, Albin TF. A comparative study of phytochemicals investigation of *Andrographis paniculata* and *Murraya koenigii*. International Journal of Pharmacy and Pharmaceutical Sciences. 2011;3(2):291-292.
26. Saidulu CH, Venkateshwar C. Gangadhar RS. Preliminary phytochemical studies of medicinal plant drug: *Withania somnifera* linn. Biolife J. Bio. & life sc. 2014;2(1):306-312.
27. Ifemeje JC, Egbuna C, Eziokwudiaso JO, Ezebuo FC. Determination of the Anti-nutrient Composition of *Ocimum gratissimum*, *Corchorus olitorius*, *Murraya koenigii* Spreng and *Cucurbita maxima*. Intl. J. Inno. Sci. Res.; 2014;3(2): 127–133.
28. Harborne J.B. Phytochemical methods. Chapman and Hall, Ltd, London. 1973;49-188.
29. Obdoni B, Ochuko P. Phytochemical studies and comparative efficacy of the crude extracts of some homostatic plants in Edo and Delta States of Nigeria. Global J. Pure Appl. Sci., 2001;8:203-208.
30. Pearson D. Chemical analysis of foods, 7th eds. Church Hill Living Stone London. 1976;7-11.
31. Harsha N, Sridevi V, Lakshmi C, Rani K, Vani NDS. Phytochemical analysis of some selected spices. Intl. J. Inno Res in Sci, Engi and Tech. 2013;2(11):6618-6621.
32. Madeo J, Zubair A, Marianne F. A review on the role of quinones in renal disorders. Springer Plus. 2013;2:139.

33. Bolton JL, Trush MA, Penning TM, et al. Role of quinones in toxicology. Chem Res Toxicol. 2000;13:135-160.
34. Anonymous. Medicinal plants: Anthraquinone glycosides. Available:http://medicinalplants.us/anthraquinone-glycosides
35. Huang Q, Lu G, Shen HM, Chung MC. Ong CN. Anti-cancer properties of anthraquinones from rhubarb. Med Res Rev. 2007;27(5):609-30.
36. Ngoci SN, Mwendia CM. Mwaniki CG. Phytochemical and cytotoxicity testing of *Indigofera lupatana* Baker F. Journal of Animal & Plant Sciences. 2011;11(1): 1364-1373.
37. Desai UR. Cardiac glycosides; 2000. Available:http://www.people.vcu.edu/~urdesai/car.htm. (Accessed on 17/06/2010)
38. Awoyinka OA, Balogun IO, Ogunnowo AA. Phytochemical screening and *in vitro* bioactivity of *Cnidoscolus aconitifolius* (Euphorbiaceae). Journal of Medicinal Plants Research. 2007;1:063-065.
39. Edeoga HO, Okwu DE, Mbaebie BO. Phytochemical constituents of some Nigerian medicinal plants. African Journal of Biotechnology. 2005;4:685-688.
40. Victor J, Siebert S, Hoare D, Wyk BV. Sekhukhuneland grasslands: A treasure house of biodiversity; 2005. Available:http://www.fao.org/ag/AGP/agpc/doc/show/SAfrica/sapaper/saessay.htm.
41. Soares MB, Brustolim D, Santos LA, Bellintani MC, Paiva FP, Ribeiro YM, Tossami, TC, Santos R. Physalins B, F and G, Seco-steroids purified from *Physalis angulata* L., inhibit lymphocyte function and allogeneic transplant rejection. Journal of International Immunopharmacology. 2005;6:408-414.
42. Khalid SA, Duddeck H, Gonzalez-Sierra M. Isolation and characterization of an antimalarial agent of the neem tree *Azadirachta indica*. J. Nat. Prod. 1989; 52:922-926.
43. Roberts SC. Production and engineering of terpenoids in plant cell culture. Journal of Nature Chemical Biology. 2007;3:387-395.
44. Kagbo H, Ejebe D. Phytochemistry and preliminary toxicity studies of the methanol extract of the stem bark of *Garcinia kola* (Heckel). The Internet Journal of Toxicology. 2009;7(2).
45. Geyid A, Abebe D, Debella A, Makonnen Z, Aberra F, Teka F, Kebede T, Urga K, et al. Screening of medicinal plants of Ethiopia for their anti-microbial properties and chemical profiles. Journal of Ethnopharmacology. 2005;97:421-27.
46. Liu H. Extraction and isolation of compounds from herbal medicines. In: Willow J, Liu H, (Eds.) Traditional Herbal Medicine Research Methods. John Wiley and Sons, Inc; 2011.
47. Farinola N, Piller N. Pharmacogenomics: Its role in re-establishing coumarin as treatment for lymphedema. Lymphatic Research and Biology. 2005;3(2):81-86.
48. Walter BM, Maria CN, Bettina M, Ruppelt P, Nuno AP. Plant natural products active against snake bite Ð the molecular approach. Phytochemistry. 2000;55:627-642.
49. Link KP. The discovery of dicumarol and its sequels. Circulation. 1959;19(1):97-107. DOI: 10.1161/01.CIR.19.1.97 PMID 13619027.
50. Anonymous. Phytochemicals. Available:http://www.phytochemicals.info/phytochemicals.php
51. Mamta S, Jyoti S, Rajeev N, Dharmendra S, Abhishek G. Phytochemistry of medicinal plants. Journal of Pharmacognosy and Phytochemistry. 2013;1(6):168-182.
52. Taubert D, Roesen R, Schömig E. Effect of cocoa and tea intake on blood pressure: A metaanalysis. Arch. Intern. Med. 2007; 167(7):626–34.
53. Rao RVK, Ali N, Reddy MN. Occurrence of both sapogenins and alkaloid lycorine in *Curculigo orchioides*. Indian Journal Pharma Science. 1978;40:104-105.
54. Sotheeswaran S, Doyle M, Aalbersberg W. Medicinal plants in the South Pacfific. Western Pacific Series No. 19. WHO Regional Publica-tions. Manial, Philippines; 1998.
55. Kenner D, Requena Y. Botanical medicine: A European professional perspective. Massachusetts. Paradign Publications. London; 1996.
56. Al-Bayati FA, Al-Mola HF. Antibacterial and antifungal activities of different parts of *Tribulus terrestris* L. growing in Iraq. Journal of Zhejiang University Science. 2008;9:154-159.
57. Schroeter H, Heiss C, Balzer J. Epicatechin mediates beneficial effects of flavanol-rich cocoa on vascular function in humans. Proc. Natl. Acad. Sci. U.S.A. 2006;103(4):1024–9.

58. Arts ICW, Hollman PCH. Polyphenols and disease risk in epidemiologic studies. Am. J. Clinical Nutr. 2005;81:317-325.
59. Joseph JA, Shukitt-Hale B. Casadesus G. Reversing the deleterious effects of aging on neuronal communication and behavior: Beneficial properties of fruit polyphenolic compounds. Am. J. Clin. Nutr. 2005; 81:313–316.
60. Lambert JD, Hong J, Yang G, Liao J, Yang, CS. Inhibition of carcinogenesis by polyphenols: Evidence from laboratory investigations. Am. J. Clin. Nutr. 2005; 81:284–291.

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