ABSTRACT

_Ceiba pentandra_ (Silk cotton) is a multipurpose tree in the province of Zaria city, Kaduna State, Nigeria, which is being exposed to uncontrolled exploitation by the natives. Samples of the plant were collected from standing trees located at Zaria city: Kofar Gayan, Rimi Doko, Kwarbai, Kofar Doka and Kofar Kibo. The study was aimed at assessing the secondary metabolites in _C. pentandra_ plant extracts of leaves, stem barks and roots. This was achieved through subjecting the extracts to phytochemical screening and gas chromatography/mass spectrometry fingerprinting (metabolic profiling) of phytochemical markers. The results of the screening revealed flavonoids, saponins, steroidal, tannins, triterpenoids and reducing sugars to be present in moderate variation, across the extracts. The metabolic fingerprinting indicated high variation among the phytochemicals obtained from the plant extracts. Where, twenty-seven (27) secondary metabolites were predicted from the methanol leaf extracts, twenty-five (25) from the methanol stem bark extracts and twenty-seven (27) from the methanol root extracts, out of which only one of the metabolites (2-hydroxypropyl ether) was predicted in all the extracts. Therefore, for a clearer and broader identification of these phytochemical markers, Nuclear Magnetic Resonance spectrometry (NMR) should be employed to determine the detailed chemical structures of the identified metabolites, which will help in determining their functions and how they can be used to improve the biodiversity of these tree species.

**Keywords:** Metabolic profile, GC-MS, Secondary metabolites, _Ceiba pentandra_.
animal forage, medicinal uses and several other utility uses. This made the tree species a "Hotcake" for the natives (Al-Amin, 2013).

The silk cotton tree colony is relentlessly being depleted by several human activities like; deforestation, the use of the timber as domestic fuel and construction processes among others. As the destruction is going unrestricted, the effect is obtrusively manifesting at least in the last two decades (Al-Amin, 2013). Unfortunately, no or less effort is being made to study this phenomenon more or less to stop it. The resulting negligence on the tree colony has incited this present research to find and provide possible solutions for the amplification of conservational (both Ex situ and In situ) actions of the plant in order to protect, conserve and beautify the environment.

MATERIALS AND METHODS

Study Area
Zaria city is located at 11° 5’ 7.9476’’N and 7° 43’ 11.8020’’ E in Kaduna State on the central high plains of Hausa-land in northern part of Nigeria (Al-Amin, 2013). The major soil type in the area is the tropical ferruginous; while along the wide gentle sloping valley bottom lands are the dark vertisol (Fadama soils). Zaria falls within the northern guinea savanna vegetation. The climax vegetation of the area was thought to be tropical deciduous, however, because nearly all the vegetation of the area had been degraded due to intense urban agriculture, fuel wood harvesting and urbanization processes, tree climax vegetation is absent except in the remnant silk-cotton tree colony around the southern suburb (Al-Amin, 2013).

Sampling Points
Sampling points were purposely selected, and includes; the Kofar Doka, Rimin Doko, Kofar Gayan, Kwarbai and Kofar Kibo (Figure 1).
Figure 1: A Map of Zaria City Showing the Five Sampling Points
Collection, Identification and Preparation of Plant Materials for Phytochemical Analyses

The fresh leaves, young stems and roots of *C. pentandra* species were collected from the above mentioned sampling points. The plant samples were identified at the Herbarium of Biological Sciences Department, Ahmadu Bello University, Zaria, with a voucher specimen (No. 7059). Collected samples were transported to Biological Sciences Department, Bayero University, Kano for laboratory analysis. The plant samples were air-dried indoors, finely powdered using a sterilized grinder for the extraction procedure.

Preparation of Extracts

The extraction scheme was performed according to the standard method adopted by Okoye and Osadede (2009). One hundred grams (100g) of powdered plant materials were subjected to solvent extraction for a period of two days by cold maceration in 99% methanol with periodic shaking. The crude methanol extract was drained, filtered and concentrated almost to dryness under reduced pressure at 40°C using rotary evaporator (Rotavapo R210/215, Buchi).

Phytochemical Screening of Extracts

The methanol extracts obtained from the above method were subjected to preliminary phyto-chemical screening following standard protocols (Poongothai et al., 2011). The extracts were screened for the presence of tannins, flavonoids, saponins, steroids, triterpenoids and reducing sugar. A portion of the extract (0.5mg) was treated with saturated solution of ferric chloride; a green-black or blue-black colour indicated the presence of tannin (Shamsudeen et al., 2009). Flavonoids detection was carried out in accordance with the method of Shamsudeen et al. (2009), where piece of magnesium ribbon was added to 4mg/ml of each extract which was followed by the addition of concentrated hydrochloric acid (HCl), drop-wise. Appearance of Crimson to magenta colour indicated the presence of flavonoids. 0.5g of each extract was shaken in 10ml of distilled water. Production of persistent foam which lasted for 15 minutes indicated the presence of saponin (Shamsudeen et al., 2009). One milligram (1mg) of the extract was dissolved in 10ml of chloroform and equal volume of concentrated sulphuric acid was added by the side of the test tube. The upper layer turns red and sulphuric acid layer showed yellow with green fluorescence. This indicated the presence of steroids (Poongothai et al., 2011). Ten milligram (10mg) of the extract was dissolved in 5ml of chloroform; 1ml of acetic anhydride was added following the addition of 2ml of conc. H₂SO₄. Formation of reddish violet colour indicates the presence of triterpenoids (Poongothai et al., 2011). Test for detection of reducing sugars was carried out in accordance with the method of Poongothai et al. (2011) where 1ml of stock solution of each extract was diluted with 2ml of distilled water, followed by the addition of Fehling’s solution (A+B) and then warmed. Brick red precipitates at the bottom of the tubes indicate the presence of reducing sugars.

Gas Chromatography-Mass Spectrometry Analysis of Extracts

GC-MS analysis of the extracts was performed using GCMS-QP2010 PLUS (Shimadzu Japan system). The sample (2 ml) was injected into a RTX-5 column (60m x 0.25mm internal diameter, film thickness 0.25 μm) of GC-MS. Helium was used as carrier gas at a constant column flow of 1.58 ml/min. at 108.0 kpa inlet pressure. Temperature programming was maintained from 80°C to 250°C with constant rise of 5°C/min. and then held isothermal at 250°C 10 min.; further the temperature was increased by 30°C/min. up to 310°C and again held isothermal at 320°C for 22 min. The injector and ion source temperature were 270°C and 230°C, respectively. Each of the extracts was dissolved in methanol, and in turn injected with a split ratio of 1:20. Mass spectra were taken at 70 eV; a scan interval of 0.5 seconds and the total GC/MS running time 70 minutes. Interpretation and identification of the spectrum of the GC-MS was obtained using the database of library in GC-MS system of the National Research Institute for Chemical Technology (NARICT), Zaria.

---

### Table 1: Preliminary Phytochemical Screening of *C. pentandra* Root Extracts from Five Sampling Points in Zaria City

| Tests            | K. Gayan | K. Kibo | R. Doko | Kwarbai | K. Doka |
|------------------|----------|---------|---------|---------|---------|
| Flavonoids       | +        |         | +       | -       | +       |
| Saponins         | -        | -       | -       | -       | -       |
| Steroids         | -        | -       | -       | -       | +       |
| Tannins          | +        | +       | +       | +       | +       |
| Triterpenoids    | -        | -       | +       | -       | +       |
| Reducing sugar   | +        | +       | +       | +       | +       |

**Key:**
- + Detected
- - Not detected
Table 2: Preliminary Phytochemical Screening of *C. pentandra* Stem Bark Extracts from Five Sampling Points of Zaria City

| Tests          | K. Gayan | K. Kibo | R. Doko | Kwarbai | K. Doka |
|----------------|----------|---------|---------|---------|---------|
| Flavonoids     | -        | -       | +       |         | -       |
| Saponins       | -        | -       | +       | -       | -       |
| Steroids       | +        | +       | +       | -       | +       |
| Tannins        | +        | +       | +       | -       | +       |
| Triterpenoids  | +        | +       | +       | -       | +       |
| Reducing sugar | -        | +       | -       | -       | +       |

Key:  
+ Detected  
- Not detected

Table 3: Preliminary Phytochemical Screening of *C. pentandra* Leaf Extracts from Five Sampling Points of Zaria City

| Tests        | K. Gayan | K. Kibo | R. Doko | Kwarbai | K. Doka |
|--------------|----------|---------|---------|---------|---------|
| Flavonoids   | -        | +       | +       | +       | -       |
| Saponins     | +        | +       | -       | +       | -       |
| Steroids     | +        | +       | -       | -       | -       |
| Tannins      | +        | +       | +       | +       | +       |
| Triterpenoids| +        | +       | -       | -       | -       |
| Reducing sugar| -       | -       | +       | -       | -       |

Key:  
+ Detected  
- Not detected
### Table 4: Identified Metabolites Obtained at Different Retention Times from the Methanol Leaf Extracts

| Retention time (Mins) | KofarGayan | RiminDoko | Kwarbai | KofarDoka | KofarKibo | Compound | Empirical Formula | Names of Compounds |
|-----------------------|------------|-----------|---------|-----------|-----------|----------|-------------------|--------------------|
| 4.0-4.5 | + | - | + | - | - | C₃H₆ | 1-octene |
| 4.6-5.0 | + | - | + | + | + | C₄H₈O | Formic acid |
| 5.1-5.5 | - | - | + | + | + | C₅H₁₀O₃ | 2-hydroxypropyl ether |
| 5.6-6.0 | - | - | - | - | - | - | - |
| 6.1-6.5 | - | - | - | - | - | - | - |
| 6.6-7.0 | - | - | - | - | - | - | - |
| 7.1-7.5 | - | - | - | - | - | - | - |
| 7.6-8.0 | + | - | - | - | + | C₁₇H₂₈NO₂ | Anthranilic acid |
| 8.1-8.5 | - | - | - | - | - | - | - |
| 8.6-9.0 | - | - | - | - | - | - | - |
| 9.1-9.5 | - | - | - | - | - | - | - |
| 9.6-10.0 | - | - | + | - | - | C₁₅H₂₄ | 1,3-dimethyl-8-(1-methylethyl) |
| 10.1-10.5 | - | - | - | - | + | C₁₅H₂₄ | 1,3-dimethyl-8-(1-methylethyl) |
| 10.6-11.0 | - | - | - | + | - | C₁₄H₂₂ | 5,9-tetradecadiyne |
| 11.1-11.5 | - | - | - | - | - | C₁₅H₂₄ | 1,3-dimethyl-8-(1-methylethyl) |
| 11.6-12.0 | - | - | - | - | - | - | - |
| 12.1-12.5 | + | - | - | - | + | C₁₃H₂₀O₂ | Tridecanoic acid ethyl ester |
| 12.6-13.0 | - | - | - | + | + | C₁₀H₁₆O | Bicyclo(3.1.1)heptan-3-one |
| 13.1-13.5 | - | - | - | - | + | C₁₀H₁₆O₂ | 7-oxabicyclo(4.1.0)heptane |
| 13.6-14.0 | + | - | - | - | - | C₁₁H₂₂O₂ | Decanoic acid |
| 14.1-14.5 | - | - | - | - | - | - | - |
| 14.6-15.0 | - | + | - | - | - | C₁₀H₂₁F | Decylfluoride |
| 15.1-15.5 | - | - | - | - | - | - | - |
| 15.6-16.0 | - | - | - | - | - | - | - |
| 16.1-16.5 | - | + | + | - | + | C₉H₁₈O₂ | 11-octadecenoic acid |
| 16.6-17.0 | + | + | + | + | + | C₁₁H₂₂O₂ | Decanoic acid |
| 17.1-17.5 | - | - | - | - | - | - | - |
| 17.6-18.0 | - | - | - | - | - | - | - |
| 18.1-18.5 | + | + | + | + | + | C₁₅H₂₀O₂ | Tridecanoic acid ethyl ester |
| 18.6-19.0 | - | - | - | - | - | - | - |
| 19.1-19.5 | - | - | - | - | - | - | - |
| 19.6-20.0 | + | + | + | + | + | C₁₇H₃₈O₂ | 9,12-hexadecadienoic acid |
| 20.1-20.5 | + | + | + | + | + | C₁₉H₃₆O₂ | 11-octadecenoic acid |
| 20.6-21.0 | + | - | + | + | + | C₁₈H₃₄O₂ | Oleic acid |
| 21.1-21.5 | + | + | + | + | + | C₁₈H₃₆O₂ | Methyl isohexadecanoate |
| 21.6-22.0 | - | - | - | - | - | - | - |
| 22.1-22.5 | + | - | + | + | + | C₁₄H₂₈ | 4-tetradecene |
| 22.6-23.0 | + | + | + | + | + | C₁₂H₂₃O₂ | Nonadecyl acetate |
| 23.1-23.5 | - | - | - | - | - | - | - |
| 23.6-24.0 | - | - | - | + | - | C₁₁H₂₃O | Dehydrogeranol |
| 24.1-24.5 | + | + | + | + | + | C₁₃H₂₄O₂ | 11,12-octadecadien-1-ol |
| 24.6-25.0 | + | + | + | + | + | C₁₁H₂₄ | 5-methyldecane |
| 25.1-25.5 | - | - | - | - | - | - | - |
| 25.6-26.0 | - | - | - | - | - | - | - |
| 26.1-26.5 | - | - | - | - | - | - | - |
| 26.6-27.0 | - | - | - | - | - | - | - |
| 27.1-27.5 | - | - | + | - | - | C₁₈H₃₄O₂ | Oleic acid |
| 27.6-28.0 | + | + | + | + | + | C₃₀H₅₀ | Squalene |
| Retention time (Mins) | KofarGayan | RiminDoko | Kwarbai | KofarDoka | KofarKibo | Compound Empirical Formula | Names of Compounds               |
|-----------------------|------------|-----------|---------|-----------|-----------|---------------------------|----------------------------------|
| 4.0-4.5               | -          | +         | -       | -         | -         | C_{5}H_{10}O               | 1,2-methyl-1-butanol             |
| 4.6-5.0               | +          | -         | -       | +         | +         | C_{6}H_{12}O_2             | 2-hydroxypropyl ether            |
| 5.1-5.5               | -          | -         | -       | -         | -         |                           |                                  |
| 5.6-6.0               | -          | -         | +       | -         | -         | C_{6}H_{10}O               | Butanoic acid                    |
| 6.1-6.5               | -          | -         | -       | -         | -         |                           |                                  |
| 6.6-7.0               | -          | -         | -       | -         | -         |                           |                                  |
| 7.1-7.5               | -          | -         | -       | -         | -         |                           |                                  |
| 7.6-8.0               | +          | -         | +       | -         | -         | C_{5}H_{10}O_4             | Acetyl monoglyceride             |
| 8.1-8.5               | -          | -         | -       | -         | -         |                           |                                  |
| 8.6-9.0               | -          | -         | +       | -         | -         | C_{6}H_{10}O_4             | Ethylene acetate                 |
| 9.1-9.5               | -          | -         | -       | -         | -         |                           |                                  |
| 9.6-10.0              | -          | -         | -       | -         | -         |                           |                                  |
| 10.1-10.5             | -          | -         | -       | -         | -         |                           |                                  |
| 10.6-11.0             | +          | -         | -       | -         | -         | C_{12}H_{26}O              | 2-butyl-1-octanol                |
| 11.1-11.5             | +          | +         | -       | -         | -         | C_{15}H_{30}O_2            | Palmitic acid, methyl ester      |
| 11.6-12.0             | -          | -         | -       | -         | -         |                           |                                  |
| 12.1-12.5             | -          | -         | -       | -         | -         |                           |                                  |
| 12.6-13.0             | +          | -         | -       | -         | -         | C_{14}H_{28}               | 3-tetradecane                    |
| 13.1-13.5             | -          | -         | -       | -         | -         |                           |                                  |
| 13.6-14.0             | +          | +         | -       | -         | -         | C_{14}H_{28}O_2            | Tridecanoic acid                 |
| 14.1-14.5             | -          | -         | -       | -         | -         |                           |                                  |
| 14.6-15.0             | -          | +         | -       | -         | -         | C_{14}H_{28}O_2            | Hexadecylcic oxide               |
| 15.1-15.5             | -          | -         | -       | -         | -         |                           |                                  |
| 15.6-16.0             | -          | -         | -       | -         | -         |                           |                                  |
| 16.1-16.5             | +          | +         | -       | -         | -         | C_{23}H_{46}O_2            | 13-docosenoic acid, methyl ester |
| 16.6-17.0             | +          | -         | +       | +         | +         | C_{14}H_{28}O_2            | Palmitic acid, methyl ester      |
| 17.1-17.5             | -          | -         | -       | -         | -         |                           |                                  |
| 17.6-18.0             | -          | -         | -       | -         | -         |                           |                                  |
| 18.1-18.5             | +          | +         | +       | +         | +         | C_{14}H_{28}O_2            | Hexadecanoic acid                |
| 18.6-19.0             | -          | -         | -       | -         | -         |                           |                                  |
| 19.1-19.5             | -          | -         | -       | -         | -         |                           |                                  |
| 19.6-20.0             | +          | +         | +       | +         | +         | C_{10}H_{34}O_2            | Linoleaidic acid, methyl ester   |
| 20.1-20.5             | +          | +         | +       | +         | +         | C_{11}H_{26}O_2            | 6-octadecenoic acid, methyl ester|
| 20.6-21.0             | +          | +         | +       | +         | +         | C_{14}H_{28}O_2            | E-9-tetradecenoic acid           |
| 21.1-21.5             | +          | +         | +       | -         | +         | C_{15}H_{32}               | 1,11-E,13Z-13-octadecatriene    |
| 21.6-22.0             | -          | -         | +       | -         | -         | C_{14}H_{28}               | 3-tetradeceno                    |
| 22.1-22.5             | +          | +         | +       | +         | +         | C_{15}H_{30}O_2            | 2-butylctyl alcohol              |
| 22.6-23.0             | +          | +         | +       | +         | +         | C_{22}H_{46}O_2            | Eicosanoic acid, methyl ester    |
| 23.1-23.5             | -          | +         | +       | -         | -         | C_{18}H_{36}NO             | Oleic acid amide                 |
| 23.6-24.0             | -          | +         | +       | +         | -         | C_{18}H_{36}O               | 1- Eicosanol                     |
| 24.1-24.5             | +          | +         | +       | +         | +         | C_{18}H_{36}O               | Octadecenyl aldehyde             |
| 24.6-25.0             | -          | +         | +       | +         | +         | C_{18}H_{36}O               | n-propyl heptyl ether            |
| 25.1-25.5             | -          | -         | -       | -         | -         |                           |                                  |
| 25.6-26.0             | -          | -         | -       | -         | -         |                           |                                  |
| 26.1-26.5             | -          | -         | -       | -         | -         |                           |                                  |
| 26.6-27.0             | -          | -         | -       | -         | -         |                           |                                  |
| 27.1-27.5             | -          | -         | -       | -         | -         |                           |                                  |
| 27.6-28.0             | -          | +         | -       | -         | -         | C_{16}H_{34}O              | Palmitaldehyde                   |
DISCUSSION
Massive loss of valuable plant species in the past centuries and its adverse impact on environmental and socioeconomic values has triggered the conservation of plant resources. Appropriate identification and characterization of plant materials is essential for the successful conservation of plant resources and to ensure their sustainable use (Arif et al., 2010).

The results of the phytochemical assessment from the five sampling points (Kofar Gayan, Rimin Doko, Kwarbai, Kofar Kibo and Kofar Doka) indicate relative variation among the extracts from the above mentioned sampling points which may have resulted from continuous cutting down of the trees for firewood and other domestic needs. It may also have been due to stress posed by environmental hazards such as pollution, drought, ultra violet
exposure, herbivory and pathogenic attack, (Ali and Alquraini, 2006).

Phytochemicals are biologically synthesized chemical compounds in plants, which serve in protecting the plant cells against environmental hazards such as: pollution, stress, and drought, ultra violet exposure, herbivory and pathogenic attack (Ali and Alquraini, 2006). Phytochemicals, also referred to as secondary metabolites, provide health benefits to humans; acting as synergistic agents, hence, allowing more efficient nutrient use by the body (Andre et al., 2010). This study identified flavonoids, saponins, steroids, tannins, triterpenoids and reducing sugar (Tables 1, 2 and 3).

Overproduction of oxidants (reactive oxygen species and reactive nitrogen species) in the human body is responsible for the pathogenesis of some diseases. The scavenging of these oxidants is thought to be an effective measure to depress the level of oxidative stress of organisms. It has been reported that intake of plant parts is inversely associated with the risk of many chronic diseases, and antioxidant phytochemicals in the plants are considered to be responsible for these health benefits. They often possess strong antioxidant and free radical scavenging abilities, as well as anti-inflammatory action, which are also the basis of other bioactivities and health benefits, such as anticancer, anti-aging, and protective action for cardiovascular diseases, diabetes mellitus, obesity and neuro-degenerative diseases (Zhang et al., 2015).

The presence of the range of phytochemicals in the different plant parts could be related to the use of the plant for medicinal purposes. Bairwa et al. (2010) reported protective activity of ethyl acetate fraction of methanol extract of stem bark of C. pentandra against induced liver damage in rats. C. pentandra root and bark extracts have been reported to have a hypoglycaemic effect (Djomeni-Dzeufet et al., 2006).

Tannins were found present in the leaves, bark, stem and the roots of C. pentandra extracts (Tables 1, 2 and 3). Tannins possess a characteristic feature of tan, i.e. they have the potential to convert things into leather (Sarker and Nahar, 2007), provide protection to the plant against microbial pathogens, harmful insects and other herbivores (Ali and Alquraini, 2006). Tannins present in the extracts of C. pentandra have being also reported by Akinpelu and Onakoya (2006) as the main component for the treatment of intestinal disorders like diarrhea and dysentery. Triterpenoids found in these plant extracts serve as a major component of many essential oils, resins or oleoresins (Firn, 2010), and are widely used in herbal medicine (Edeoga et al., 2005). Many sesquiterpene lactones with moderate antimicrobial activity have been isolated from the root bark of C. pentandra (Rao et al., 1993). Flavonoids presented in the Tables 1, 2 and 3 have a number of nutritional functions and have been described as biological response modifiers’, mostly act as anti-oxidant and some have anti-inflammatory properties or as free radical scavengers (Kar, 2007). Flavonoids were also described as phyto-constituents serving as flavouring agents of spices and vegetables (Osuntokun et al., 2017). Isoflavone glucosides isolated from the bark of C. pentandra showed inhibitory effects on cyclooxygenase-2-catalyzed prostaglandin biosynthesis indicating an analgesic potential (Noreen et al., 1998). The steroids otherwise termed as steroid glycosides or cardiac glycosides are plant phyto-constituents having therapeutic applications as arrow poisons or cardiac drugs (Firm, 2012), they are also reported to have the ability to promote nitrogen retention in osteoporosis and in animals with wasting illness Madziga et al. (2010). Saponins as presented in Tables 2 and 3 possess hypolipidemic and anticancer activity, and therefore, necessary for cardiac glycosides activities, steroidal saponins are used in the commercial production of sex hormones for clinical use (Sarker and Nahar, 2007). The result of these phytoconstituents in C. pentandra further suggested the reason for the usage of the plant in curing many diseases such as colic in man, dressing of sores for tumors, whitlow, inflammatory diseases, cancer, fatigue, lumbago, gonorrhea, dysentery, anti-microbial and anti-fungal effects (Edeoga et al., 2001). Since these phytochemicals are present in all the targeted organs in the plant, the use of root and stem bark of the plant should be discouraged to ensure sustainable usage of the plant, as the use of root in particular can result in destructive usage.

Variation in biosynthesis of these metabolites may be resulted from both genetic and environmental factors, which play important roles in the development of phenotypic variations in plants as reported by Salim et al. (2011).

Some of the compounds revealed in the GC-MS analysis includes: Squalene; a triterpene which is an intermediate for phytosteryl biosynthesis in plants extracts (Table 4) and is highly appreciated in the cosmetic and pharmaceutical industry due to its remarkable properties; easy incorporation in cosmetic emulsions as effect of its light consistency and excellent spreadability, non-greasy texture, high stability, also due to the fact that the plant origin squalene is odourless and colorless with no harmful substances, as such serve as an potentiating for chemothierapeutic drugs (Ioana et al., 2014). Linalool or Linalyl acetate is a naturally occurring aromatic compound (Table 5), which is regarded as substantial criteria in the authenticity control of essential oils and also adopted for quality assurance by the flavor and fragrance industry (Kreis and Mosandi, 1992). Decanoic, Pentadecanoic, Hexadecanoic, Octadecanoic and Eicosanoic acids are saturated fatty acids (Tables 4-6) and serve as important component in the cosmetic industry (CHEMIK, 2014). They are primarily used as intermediates in the manufacture of corresponding alkali salts, which are in turn, used as emulsifiers, emollients, and lubricants in a variety of cosmetic creams, cakes, soaps and pastes (Mary, 1987), these compounds extracted from the leaves of Sesuvium portulacastrum revealed their ability to have the potential antimicrobial agents against tested human pathogenic microorganisms (Chandrasekaran, and Santhikumar, 2011). Anthranilic acid and its derivatives as presented in Table 4 have applications in various sectors, including; food and perfume industries, and are used in the synthesis of bioactive molecules (Wiklund and Bergman, 2006). It also exhibits anticancer, antimicrobial, insecticide, antiviral and anti-inflammatory activities (Pajor and Sun, 2013).

The above result was further collaborated and confirmed by metabolic fingerprinting of the Secondary metabolites (phytochemical markers) using GC-MS technique, thus, revealed the presence of pre-cursor molecules to the above mentioned compounds (phytochemicals). These compounds includes; 2-hydroxypropyl ether, E-9-tetradecenal, 11-tridecene-1-ol, E-2-hexadecen-1-ol, Palmitic acid methyl ester, Linolealidic acid methyl ester, 13-octadecatriene, Acetic, (2,4-dinitro-6-S-butylyphenyl), Butanoic acid, Hexadecanoic acid, Acetic acid octadecyl ester, Linolealidic acid methyl ester, 6-octadecenoic acid, Isoeitronellol, Undecylenic aldehyde, Decylfluoride, Nanodecyl acetate, 9,12-octadecadien-1-ol, 5-methyl decane, Squalene among others. These compounds were found to be diverse among extracts based on their retention time range.
CONCLUSION
In conclusion, the result of this study revealed variation among C. pentandra species found around Zaria city, on the basis of the phytochemical markers analytes (secondary metabolites) produced by the extracts, there was relative diversity among the secondary metabolites contained in the extracts. Differences in metabolites at ranges of retention times were observed among the samples obtained from different sites. Analysis of the leaf extract at retention time of 4.0-4.5 minutes indicated the presence of 1-octene only in C. pentandra from K. Gayan and Kwarhai. Conversely, at a retention time ranging from 18.1-18.5 minutes, tridecanolic acid ethyl ester was identified in all the leaf samples. Furthermore, while most of the metabolites were observed to be present only in either the leaf, root or stem bark extracts, few others such as 2-hydroxypropyl ether were found to be common to all the extracts. Hence, the biotechnological tool (GC-MS) is one of the important techniques used for the improvement of plant species, which are important economically and medicinally, and may also have a positive impact in their conservation.

REFERENCES
Akinpelu, D.A. and Onakoya, Z.T.M. (2006). Antimicrobial Activities of Medicinal Plants Used in Folklore. Remedies in Southwestern Nigeria. African Journal of Biotechnology, 7(5): 1078-1081.

Al-Amin M.A. (2013). Impact of Indiscriminate Land Uses in Species Abundance: Case Study of Silk Cotton Tree Ceibapentandra Colony at Southern Suburb of Zaria City. Nigeria. British Journal Of Environmental Sciences, 1(1): 1-6.

Ali, A.A and Alquairani, F. (2006). Activities of antioxidants in plants under environmental stress. The lutein-Prevention and Treatment for Diseases. P.187-256.

Andre, C.M., Larondelle, Y. and Evers, D. (2010). Dietary Antioxidants and Oxidative Stress from a Human and Plant Perspective: A Review Current Nutrition & Food Science, 6(1): 2-12.

Anurag, K., Raghveer, I., Anumalik, Y., Nitika, G., Swadesh, K., Nikil, G., Santosh, K., Vinay, Y., Anuj, P. and Himanshu, G. (2014). Metabolites in Plants and Its Classification. World Journal of Pharmacy and Pharmaceutical Sciences, 4(1): 287-298.

Arif, I.A., Bakir, M.A., Khan, H.A., Al Farhan, A.H., Al Homaidan, A.A., Bahkali, A.H. Al Sadoon, M. and Shobrak, M. (2010). A Brief Review of Molecular Techniques to Assess Plant Diversity. International Journal of Molecular Sciences, 6: 2079–2096.

Bairwa, N. K, Neeraj, K.S. and Mishra, S.H. (2010). Protective Effect of Stem Bark of Ceiba pentandra Linn. against Paracetamol-Induced Hepatotoxicity in Rats. Pharmacognosy Research, 2(1): 26-30.

Bourgaud, F., Gravot, A., Milesi, S. and Guntier, E. (2001): Production of Plant Secondary Metabolites: A Historical Perspective. Plant Science, 161: 839-851.

Chandrasekaran, M. and Senthilkumar, V. (2011). Antibacterial and Antifungal Efficacy of Fatty Acid Methyl Esters from the Leaves of Sesuvium portulacastrum L. European Review for Medicinal and Pharmacological Sciences, 15: 775-780.
Cyclooxygenase-catalyzed Prostaglandin Biosynthesis. *Journal of Natural Products*, **61** (1): 8-12.

Okoye, F.B.C and Osadede, O.P. (2009). Study on the Mechanism of Anti-Inflammatory Activity of the extracts and fractions of *Alchornea floribunda* leaves. *Asian Pacific Journal of Tropical Medicine*, **3** (3): 7- 14.

Oleszek, W. and Marson, A. (2000). *Saponins in Food and Medicinal Plants*. Kluwer Academic Publishers. New York, p. 1-95.

Osuntokun, O.T., Ayodele, A.O., Adeyeye, M.I. and Odulufunwa, A.E. (2014). Assessment of Antimicrobial and Phytochemical Properties of *Ceibapentandra* Leaf and Bark Extracts of *Ceibapentandra* on Selected Clinical Isolates Found in Nigerian Teaching Hospital. *Journal of Bacteriology and Mycology*, **4** (1): 00079.

Pajor, M and Sun, N.N. (2013). Nonsteroidal Anti-Inflammatory Drugs and Other Anthranilic acid Inhibitors of Hepatitis C NS5B Polymares; *Journal of Medicinal Chemistry*, **50**: 2108-2116.

Poongothai, A. Sreena, K. P. Sreejith, K. Uthinalinggam, M. and Annapoorani, S.(2011). Preliminary Phytochemicals Screening of FicusBasemosalinn bark. *International Journal of Pharmacy and Biomedical Science*, **2**: 432-433.

Rao, K.V., Sreeramulu, K., Gunasekar, D. and Ramesh, D. (1993). Two New Sesquiterpene Lactones from *CeibaPentandra*. *Journal of Natural Products*, **56** (12): 2041–2045.

Ravi, K.C., Rao, D.B., Sirisha, N. and Rao, T.R. (2015). Assessment of Phytochemicals and Antioxidant Activities of Raw and Germinating *CeibaPentandra* (Kapok) Seeds. *Journal of Biomedical Research*, **29** (5): 414-419.

Salim, K., Rajeev, K.S. and Malik, Z.A. (2011). Assessment of Phytochemical Diversity in *Phyllanthusamarus* using HPTLC Fingerprints. *Indo Global Journal of Pharmaceutical Sciences*, **1** (1): 1-12.

Samuni-Blank, M., Izhaki, I., Dearing M. D., Gerchman, Y., Trabelcy, B., Lotan, A., Karasov, W. H., and Arad, Z. 2012. “Intraspecific Directed Deterrrence by the Mustard Oil Bomb in a Desert Plant”. *Current Biology*, **22** (13): 1218-1220.

Sandhya, B., Thomas, S., Isabel, W. and Shenbagarathai, R. (2006). *Complementary and Alternative Medicines*, **3**: 101-114.

Sarker, S.D. and Nahar, L. (2007). *Chemistry for Pharmacy Students General, Organic and Natural Product Chemistry*, England: John Wiley and Sons, p. 283-359.

Saurabh, P., Manila, B., Niraj, T., Sonal, P. and Bansal, Y.K. (2015): Secondary Metabolites of Plants and their Roles, *Overview. Current Trends in Biotechnology and Pharmacy*, **9** (3): 293-304.

Shamsuddeen, U., Ameh, J.B., Oyeyi, T.J and Dantata, A.A. (2009). Study on the Phytochemical and *In Vitro* Antibacterial Activity of Some Spice Extracts on Some Bacteria Isolated from Meat Products. *Bayero Journal of Pure and Applied Sciences*, **2** (1): 102-103.

Stamp, N. (2003). “Out of the Quagmire of Plant Defense Hypotheses.” *The Quarterly Review of Biology*, **78** (1): 23-55.

Thrane, U. (2001). “Development in the Taxonomy of Fusarium Species Based on Secondary Metabolites.” In: *Fusarium*: Paul E. Nelson memorial symposium, edited by B.A. Summerell. St. Paul, Minnesota: APS Press, p. 29-49.

Tian-nian, S., Bamba, T. and Fususaki, E. (2010). Pyrolysis GC-MS based metabolite fingerprinting for quality evaluation of commercial *Angelica acutiloba* roots. *Journal of Bio Sciences*, **109** (1): 89-93.

Waterman, P.G. (1992). “Roles for Secondary Metabolites in Plants.” In Proceedings of the 171st Ciba Foundation Symposium on Secondary Metabolites: Their Function and Evolution, 255-75.

Wiklund, P. and Bergman, J. (2006). The Chemistry of Anthranilic acid. *Current Organic Synthesis*, **3**: 379-402.

Zhang, Y.J., Gan, R.Y., Li, S., Zhou, Y., Li, A.N., Xu, D.P. and Li, H.B. (2015). Antioxidant Phytochemicals for the Prevention and Treatment of Chronic Diseases. *Molecules*, **20** (12): 21138–21156.