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Qualitative and Quantitative Phytochemicals Screening of Aqueous, Methanol and Hexane Leaves Extracts of Senna Occidentalis

Alkali K. [a*], Dikwa K. B. [b], G.A. Ajibade [c], Y Magaji [c] and Abdulhamid M.B [c]

[a] Department of G.S.T and Remedial, Mohammed Goni College of Legal and Islamic Studies, Nigeria.
[b] Department of Biological Science, Nigerian Defence Academy, Kaduna, Nigeria.
[c] Department of Medical Laboratory, University of Maidugur, Nigeria.

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

The *Senna occidentalis* tree is an incredible plant with incredible antimicrobial, antifungal and antimalarial activities used traditionally. The study was carried out to determine the phytochemical content responsible for these activities Fresh leaves were collected, aqueous, methanolic and hexane extracts of leaves were prepared, and the extracts were screened for phytochemical constituents using standard methods. Results of the phytochemical screening of all the crude extracts revealed the presence of saponins, tannins, steroids, phenol, alkaloid and flavonoid. In aqeuose extract, flavonoid show higher content of 2,47%, followed by tepernoid with 2.27%, methanol with higher content of tepernoid with 2.60%, and hexane with the highest in tepernoid

**Corresponding author: E-mail: kaumi_alkali@yahoo.com;*

with only 2.38%. Based on the present study, it can be concluded that the extracts of *Senna occidentalis* are rich source of phytochemicals and ~~F~~ flavonoid is found to be most abundant phytochemical presence of bioactive constituents that could be the reason for pharmacological activity that is used traditionally by many people as an alternative treatment for a variety of health diseases.

Keywords: Senna occidentalis; phytochemical; aqueous; methanol; hexane.

1. INTRODUCTION

"Senna (from Arabic *sanā*), the sennas, Commonly known as kasundi or Negro coffee belongs to flowering plants in the legume family Fabaceae, and the subfamily Caesalpinioideae. Nearly all species of the family exhibit the is the third largest family of the flowering plants [1], being the sources of gums, dyes, oils, insecticides, fiber, fuel, timber, medicinal formation of root nodulation with symbiotic bacteria to fix atmospheric nitrogen and thereby improving the soil fertility" [2]."This diverse genus is native throughout the tropics, with a small number of species in temperate regions. The number of species is estimated to be from about 260 to 350" [3]. "The type species for the genus is *Senna alexandrina*. About 50 species of *Senna* are known in cultivation" [4]. "Pharmacological investigations have revealed the presence of several activities -antioxidant, analgesic, antipyretic, anti-inflammatory, hepatoprotective, antimalarial, antidiabetic, anticancer and antidepressant activities. This plant is also an ingredient of a commercially available formulation (Liv-52 Produced by Himalaya Drugs, India) and used in treatment of liver disorders" [5]. "Leaves, seeds and pods were found to have antifungal activity against Candida albicans, Aspergillus clavatus and A.nige" [6]. "Muscle-Relaxant Effect: Aqueous extract of the leaves was found to inhibit aortic ring contractions elicited by noradrenaline and potassium chloride in a dose dependent manner" [7]. "Anti-diabetic activity: Hypoglycaemic activity of leaves was evaluated in male albino Wistar rats. Methanolic and aqueous extracts of leaves exhibited significant reduction in fasting blood glucose levels and plasma insulin indiabetic rats" [7]."Butanolic and aqueous extracts of the leaves were able to exert antidiabetic effects in alloxan-induced diabetes model in mice" [8]. "Aqueous extract of leaves had shown antidiabetic activity in alloxan- Induced diabeticmodel" [9]. "Aqueous extract of leaves (30 and60 mg/ml) exhibited significant inhibitory activity against *Escherichia coli* And *Salmonella typhi"* [10]. "Chloroform and aqueous extracts of leaves exhibited no activity against E. coli. Aqueous extract was able to remarkably inhibit the growth of Pseudomonas aeruginosa" [11]. "Methanolic, hexane, chloroform and aqueous extracts of the leaves were able to inhibit growth of E. coli, Methanolic and aqueous extracts of the leaves showed activity against *P. aeruginosa*, *P. mirabilis* and *Candida albicans"* [12]. "*Senna occidentalis*, plant is considered to be the richest sources of drugs for traditional medicine, modern medicine, nutraceuticals, food supplements, folk medicine, pharmaceutical intermediates and chemical entities for synthetic drugs [13] and this could be attributed to phytochemicals present in the plant" [13]. The objective of this study was to screen the phytochemical constituents of aqueous, methanol and hexane leaves extracts of *S. occidentalis* and relate it to some of its traditional use.

2. MATERIALS AND METHODS

2.1 Collection of Sample

Fresh and mature leaves of *Senns occidentalis* fresh mature leaves was obtained at Jiddari polo Maiduguri, Borno State. The samples were collected in a clean sterile polythene bag and brought to the herbarium of the Department of Biological Sciences, Nigerian Defence Academy Kaduna, for identification and authenti~~fi~~cation with Voucher specimen number NDA/BIOH/2023/51. Three different solvent extraction method were employed for the plant material that is polar solvent, intermediate polar and non-polar to determine the extract with higher phytochemical yield, Aqueous for polar, methanol for intermediate polar and hexane for non-polar.

2.2 Sample Preparation

The fresh samples of the plants were rinsed in water and air dried under shade for three weeks. Dried samples were milled to powder using grinding machine. The samples were stored in sterilized polythene bags prior to use.

2.3 Extraction

2.3.1 Preparation of aqueous crude extracts

"Fifty grams (50 g) of each of the sample of *Senna occidentalis* was extracted separately with 1500 mL of distilled water in 2000 mL beaker. The soaked samples were stirreds and covered with aluminium foil and kept for twenty-four hours. The resultant extract were filtered using muslin cloth and each filtrate were evaporated separately to dry using hot plate set at 40° C to obtain crude extract. The crude extract of each plant was weighted and stored in refrigerator until use" [14].

2.3.2 Preparation of methanol crude extracts

"The powder samples (50 g) were extracted with methanol solvent (500 mL) by using Soxhlet extractor for 72 h. After complete extraction, the methanol solvent was evaporated by using rotary evaporator (Yamato, Rotary Evaporator, model-RE 801) under reduced pressure to obtain methanol crude extract. The methanol crude extract from each sample was suspended in water (60 mL). All crude extracts were filtered separately through Whatman filter paper to remove particles. The particle free crude extract was evaporated completely by using rotary evaporator under reduced pressure to obtain dry crude extracts. The residue left in the separator funnel was re-extracted twice following the same procedure and filtered" [14].

2.3.3 Preparation of hexane crude extracts

"The leaves were dried under shade. After drying, sample was milled in to fine powder using Willye-type mill and the powder was stored protected from light and moisture at 28 °C until use. The extract was prepared in a Soxhlet apparatus using 100 g of the powdered leaves and 1 L of *n*-hexane. The solvent was evaporated at 75 rpm and 64.4 °C in a HB10 rotary-evaporator. The resulting material after solvent evaporation was the crude extract" [15]. Percentage yield will be calculated as follows

$$\text{Percentage yield} = \frac{W_1}{W_2} \times 100$$

Where:

W_1= net weight of powdered extract in grams after extraction.

W_2= total weight of powder weighed in grams before extraction

2.4 Qualitative Phytochemical Screening of Leaf Extracts

The leaves extracts of the plant were screened for metabolites such as alkaloids, tannins, flavonoids, saponinins, balsams, anthraquinones, cardiac glycosides, glycosides, and steroids.

2.4.1 Test for alkaloids (Dragendoff's Test)

About 0.2 g of each plant sample was added in to 3 ml of hexane in a test tube. These were mixed, shacked and filtered. Then 5 ml of 2 % HCl was poured in to a test tube containing the mixture of plant extract and hexane. The mixture was Heated and then filtered. Few drops of picric acid was poured in the filtrates. Formation of yellow color precipitate indicates the presence of alkaloids [16].

2.4.2 Test for tannins (Ferric Chloride Test)

"Two milliliters (2 mL) of the extract was added to 2 mL of water, and then 1 to 2 drops of diluted ferric chloride solution was added. A dark green or blue green coloration indicates the presence of tannins" [16].

2.4.3 Test for flavonoids (H_2SO_4 Test)

"About 0.5 g of each plant extract was added in to a different test tube containing 10 mL of distilled water, 5 mL of dilute ammonia solution was then added to a portion of the filtrate of each plant extract followed by addition of 1 mL concentrated H_2S0_4. Indication of yellow color shows the presence of flavonoid in each extract" [16].

2.4.4 Test for saponins (Frothing Test)

"Few volumes of distilled water was added to 1 mg of each plant extract in a test tube. The solution was then shaken vigorously and observed for a stable persistent froth for 20 min; formation of layer of foam indicates the presence of saponins". (Sabri et al., 2012)

2.4.5 Test for terpenoid steroids (Liebermann Burchard's Test)

"Ten milliliters (10 mL) of each extract were evaporated. The residue were then dissolved in 0.5 mL of hot acetic anhydride; 0.5 mL of the

filtrate chloroform was added and then treated with Liebermann Burchard's reagent. The appearance of blue-green at the interphase, confirms the presence of steroids" [16].

2.4.6 Test for anthraquinone: (Borntrager's TEST)

"Two milliters of 10% hydrochloric acid was added to the extract in the test tube and boil for 2 minutes. Equal amount of chloroform was added to test tube and vortexes twice. The chloroform layer was pipetted out and then equal volume of ammonia was added to the chloroform later. A pinkish layer indicates the presence of anthraquinones" [17].

2.4.7 Test for glycosides (Fehling's Test)

"About 2.5 of 50% sulphuric acid was added to 5ml of the extract in a test tube. The mixture was heated in boiled water for 15min, cooled and neutralized with 10% NaOH and 15mL of Fehling's reagent was added and mixture was boiled. A brick-red precipitate was observed which indicate the presences of glycocides" [18].

2.4.8 Test for cardiac glycosides (Keller-Kiliani's Test)

"About 2 mL of 0.5% ferric chloride solution was added to 1ml of the extract in a test tube and allowed to stand for 1 min. One milliliter (1 ml) of 10% H_2SO_4 was carefully poured down the wall of the test tube. The reddish-brown ring at middle of the two layers indicates the presence of cardiac glycosides [19].

2.4.9 Test for saponins glycosides (Fehling's Test)

"About 2.5mL of Fehling's reagent was added to 2.5ml of the extract in a test tube. A bluish green precipitate shows the presence of saponin glycosides" [19].

2.4.10 Test for volatile oils (HCL Test)

"Ninety percent (90%) of HCl was mixed with each extract. A white precipitate confirms the presence of volatile oils" [17].

2.4.11 Test for balsams: (Ferric Chloride Test)

"The extract 2.5ml was mixed with equal volume of 90% ethanol. Two drops of alcoholic ferric chlorides solution was added to the mixture. A dark green color indicates the presence of balsams" [19].

2.5 Quantitative Estimation of Alkaloids

"One (1 mg) of the plant extract was dissolved in dimethylsulphoxide and added 1ml of 2N HCl and filtered. This solution was transferred to a separating funnel, 5ml of bromocresol green solution then 5ml of phosphate buffer was added. The mixture was shaken with 1, 2, 3 and 4ml of chloroform by vigorous shaking and was collected in a 10ml volumetric flask and diluted to the volume with the chloroform. A set of reference standard solutions of atropine (20, 40, 60, 80 and 100µg/ ml) was prepared in the same manner as described already. The absorbance for standard solutions and test solutions was determined on the reagent blank at 470nm with an UV/Visible spectrophotometer. The content of alkaloids was expressed as mg of AE/g of plant extract" [20].

2.6 Quantitative Estimation of Flavonoids

"Colorimetric assay was used to determine the total content of flavonoid using aluminium chloride for the reaction, the plant extract of 1 ml and distilled water of 4 ml was taken in a 10 ml of flask. 0.30 ml of 5 % sodium nitrite and after 5minutes, 0.3ml of 10 % aluminium chloride was mixed in the flask. 5minutes later, 2 ml of 1M NaOH was treated and diluted using 10 ml distilled water. A set of standard solutions of quercetin (20, 40, 60, 80 and 100µg/ml) was prepared. The absorbance was measured for test and standard solutions using reagent blank at 510nm wavelength by UV-Visible spectrophotometer. The total content of flavonoid was expressed as mg of QE/g of extract" [20].

2.7 Quantitative Estimation of Glycosides

"Eight (8ml) of plant extract was transferred to a 100ml volumetric flask and 60ml of H2O and 8ml of 12.5% lead acetate was added, mixed and filtered.50ml of the filtrate was transferred into another 100ml flask and 8ml of 47% Na2HPO4 was added to precipitate excess Pb2+ ion. This were mixed and completed to volume with water. The mixture was filtered twice through same filter paper to remove excess lead phosphate. 10ml of purified filtrate was transferred into clean Erlyn – Meyer flask and treated with 10ml Baljet reagent. A blank titration was carriedout using 10ml distilled water and 10ml Baljet reagent. This was

allowed to stand for one hour for complete colour development. The colour intensity was measured colorimetrically at 495nm with an UV/Visible spectrophotometer" [21].

2.8 Quantitative Estimation Terpenoid

Approximately 100mg plant material in screw capped tubes and freeze in liquid nitrogen at 80º C for 1-2 months, the sample tissue was homogenized with 95% (v/v) methanol in pre-cooled teflon adaptors for 5 min at 30 Hz, tungsten carbide was removed with magnet a magnet and the sample was incubated sample at room temperature for 48h in dark. The sample was centrifuged for 15 min at room temperature for and supernatant was collected in a fresh 2 ml micro-tube. 1.5 chloroform was added in each 2 ml micro centrifuge tube. Standard curve 200µl of linalool solution in methanol was added to 1.5 ml of chloroform and serial dilution was done. Linalool solution in methanol was added to 1.5 ml chloroform and serial dilution of 12.965- 1.296µm linalool concentration, dilution total volume of 200 µl was made up, total volume of 200µl was made up by addition of 95% (v/v) methanol. The sample mixture was vortex thoroughly and allow to rest for 3min. 100µl Sulfuric acid (H2SO4) was added to each 2 ml micro centrifuge tube, the assay tube was incubated at room temperature for 1.5-2h in dark. At the end of incubation time a reddish brown precipitation was formed in each assay, all supernatant reaction mixture was gently removed without disturbing the precipitation. The reddish brown precipitation is partially soluble in reaction mixture solution. 1.5 ml of 95% methanol was added and vortex thoroughly until all the precipitation dissolve in methanol completely, the sample assay tube was transferred to colorimetric cuvette 95 %(v/v) methanol was used as blank] and measured at 538nm with an UV/Visible spectrophotometer [22].

2.9 Quantitative Estimation of Saponins

"Test extract was dissolved in 80% methanol, 2ml of Vanilin in ethanol was added, mixed well and the 2ml of 72% sulphuric acid solution was added, mixed well and heated on a water bath at 60 0c for 10min, absorbance was measured at 544nm with an UV/Visible spectrophotometer against reagent blank. Diosgenin is used as a standard material and compared the assay with Diosgenin equivalents" [23].

2.10 Quantitative Estimation of Anthraquinones

"The extract (1.00 g) was accurately weighed and distilled water (30 ml) was added. The mixture was mixed, weighed and refluxed on a water bath for 15 minutes. The flask was allowed to cool, weighed, adjusted to the original weight with water and the mixture was centrifuged at 4000 rpm for 10 minutes. Twenty milliliters of the supernatant liquid was transfered to a separatory funnel and acidified with 2 M hydrochloric acid. Fifteen milliliters of chloroform was added, the mixture was extracted and the chloroform layer was discarded. The extraction was done triplicate. The aqueous layer was separated and 0.10 g of sodium bicarbonate was added. The mixture was then shaken for 3 minutes and centrifuged at 4000 rpm for another 10 minutes. Ten milliliters of the supernatant liquid was transferred to a 100 ml flask. The solution of 10.5% w/v ferric chloride hexahydrate (20 ml) was added and mixed. The mixture was refluxed on a boiling water bath for 20 minutes. Concentrated hydrochloric acid (1 ml) was added and the mixture was heated for 20 minutes, with frequently shaking to dissolve the precipitate. The mixture was cooled, transferred to a separatory funnel and shaken with 25 ml diethyl ether" [24]. "The partition was repeated until anthraquinones were exhaustively extracted, tested by the Borntrager's reaction. The diethyl ether extracts were combined and washed with 15 ml distilled water twice. The combined diethyl ether was then transferred to a 100 ml volumetric flask and adjusted to volume. Twenty five milliliters of the solution was evaporated to dryness. The residue was dissolved with 10 ml of 0.5% w/v magnesium acetate in methanol yielding a red solution. The UV absorbance was measured at 515 nm" [24].

2.11 Quantitative Estimation of Tanins

"The tannin contents were determined using Folin Denis Reagent. In that method, a standard calibration curve was prepared and the Absorbance (A) against concentration of tannins at specific wave length. Suitable aliquots of the tannin-containing extract (initially: 0.05, 0.2 and 0.5 mL) were pipetted in test tubes, the volume was made up to 1.00 mL with distilled water, then 2.5 mL of sodium carbonate reagent were added. Then the tubes were shaken and the absorbance was recorded at 725 nm after 40 min. The amount of total phenols was calculated as tannic acid equivalent from the standard curve" [25].

2.12 Data Analyses

Data obtained from the study were subjected to statistical analysis using statistical package for social science (SPSS version 25.0.) Analysis of variance (ANOVA) were carried on the data, at 95% level of significant and mean generated from this study were separated using List Significant Difference (LSD).

3. RESULTS

The percentage yields of the leaves extracts in aqueous, methanol and hexane indicates that aqueous extract yield higher extract with 18.829% then methanol with 9.62% and hexane with lowest yield of 7.20%. The result was presented in Table 1.

The results of the qualitative analysis of *Senna occidentalis* is presented in Table 2. The result Reveals the presence of tannins, saponins alkaloids, glycosides, flavonoid balsams, steroids, saponin glycocides and cardial glycocides in aqueous extract and methanol shows the presence of tannins, saponins alkaloids, glycosides, flavonoid balsams, steroids, saponin glycocides, cardial glycocides and Volatile Oils while hexane extract indicate the presence of steroids, Terpenoids, tannins, flavonoid and cardial glycocides and Volatile Oils.

Table 1. Percentage yields of the leaves extracts

Extracts	Aqueous	Methanol	Hexane
Yield (%)	18.82	9.62	7.20

The result of the quantitative phytochemical analysis of *S. occidentalis* aqueous, methanol and hexane leaves *extracts* are presented in Table 3. The result showed significant amount of Alkaloids in aqueous and methanol, Terpenoids in all three solvent, Flavonoid in aqueous and methanol, Saponins in aqueous, Anthraquinones in aqueous and methanol leaves extracts and Tannins in aqueous extract.

Table 2. Qualitative phytochemical component of aqueous, methanol and hexane leaf extracts of *Senna occidentalis*

Phytochemical components	Aqueous	Methanol	Hexane
Alkaloids	+	+	-
Saponin glycocides	+	+	-
steroids	+	+	+
Tannins	+	+	+
Terpenoids	+	+	+
Cardial Glycosides	+	+	+
Flavonoid Balsams	+	+	+
Volatile Oils	-	+	+
Saponins	+	+	-
Anthraquinones	+	+	-

Key: - Absent. + Present

Table 3. Quantitative phytochemical component of leaf extracts of *Senna occidentalis*

Phytochemical Component	Aqueous	Methanol	Hexane
Alkaloids (%)	1.63±0.07^{b}	0.38±0.00^{a}	0.00±0.00^{a}
Terpenoids (%)	2.27±0.00^{a}	2.60±0.00^{a}	2.38±0.01^{b}
Flavonoid (%)	2,47±0.05^{b}	0.04±0.00^{a}	0.00±0.00^{a}
Saponins (%)	0.00±0.00^{a}	0.10±0.00^{c}	0.02±0.00^{b}
Glycosides (%)	0.01±0.00^{a}	1.30±0.00^{b}	0.06±0.00^{a}
Anthraquinones (%)	1.12±0.14^{b}	1.10±0.00^{b}	0.00±0.00^{a}
Tannins (%)	1.20±0.01^{b}	0.02±0.00^{a}	0.00±0.00^{a}

Values are mean ± standard deviation of 3 replications, means in a column with different superscripts are significantly different (P≤0.05)

4. DISCUSSION

Qualitative phytochemical analysis result aqueous and methanol leaves extracts Reveals the presence of tannins, saponins alkaloids, glycosides, flavonoid balsams, steroids, saponin glycocides and cardial glycocides in aqueous extract and methanol shows the presence of tannins, saponins alkaloids, glycosides, flavonoid balsams, steroids, saponin glycocides, cardial glycocides and Volatile Oils while hexane extract indicate the presence of steroids, Terpenoids, tannins, flavonoid and cardial glycocides and Volatile Oils. Similar bioactive compounds were also earlier observed on whole plant of *S. occidentalis [26].* Egharevba *et al.* 2013, reported the presence of carbohydrates, saponins, sterols, flavonoids, resins, alkaloids, terpenes, anthraquinones, glycoside and balsam in *S. occidentalis.* The phytochemical study of *A.indica,* S.occidentalis *and S.siamea* Hexane extract leaves extract of *S.siamea* revealed the presence of cardiac glycosides, terpenes, sterols, and volatile oil. This report is in line with report by Tamasi *et al.,* [27] who reported presence of tepernoid in *S. occidentalis* and [28,30]. But in not in agreement with Daskum, *et al.,* [31] and this could be attributed to the location of the plant.

The quantitative phytochemical screening of *S.occidentalis* leaves extract revealed the presence of significant content of Flavonoids with 2.24% in aqueous extract while methanol with significant low content of 0.04%, Tepernoids with 2.27% aqueous, 2.26% methanol and 2.38% Hexane extracts, Anthraquinones with 1.12% aqueous and 1.10% methanol. Saponins with significant low content of 0.10% aqueous and 0.02% methanol, Alkaloids with 1.63% and 0.38% for aqueous and methanol respectfully Aqueous with low content of 1.81%, very low content was recorded in aqueous and hexane extract glycosides with 0.01 and 0.66% respectively while methanol with 1.30%. Tanins show low content of 1.20% for aqueous and and significantly low content of 0.02% methanol extract, Glycosides with 1.30 with methanol extract and significant low content of aqueous and hexane with 0.01 and 0.66% At (P<0.05) significant, these findings are in conformity with that of Ujah *et al.,* [32]and Ajuru *et al.,* 2017) who reported Ethanol/water extract show 1.47% of Tannins, 2.22% of Alkaloids, Saponin 1.58%, Glycosides 2.13%, Terpenoid 2.75%, Flavonoids 2.17%, Steroids 1.10% and 1.32 % of Phenol, and report by Tamasi *et al.,* 2012) that, hexane extract shows 1.5% of Saponin and 6% of Terpenoid. The presence of bioactive compound in *Senna occidentalis* is an indication that it has medicinal potentials due to the fact that each of the bioactive compounds identified has one or more uses therapeutically [33-35]. This also explains the rampart use of *S. occidentalis* by the people [36,37].

5. CONCLUSION

Based on the present study, it can be concluded that the extracts of *Senna occidentalis* are rich source of phytocemicalcs. Flavonoid is found to be most abundant phytochemical, though alkaloids is in very high concentration as well. The phytochemical screening revealed the presence of bioactive constituents that could be the reason for pharmacological activity that is used traditionally by many people as an alternative treatment for a variety of health deseases.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. LPWG The Legume Phylogeny Working Group. A new subfamily classification of the Leguminosae based on a taxonomically comprehensive phylogeny. Taxon. 2017;66 (1): 44–77. DOI: 10.12705/661.3
2. Abd-Alla MH, Al-Amri SM, El-Enany A.-WE. Enhancing Rhizobium–Legume Symbiosis and Reducing Nitrogen Fertilizer Use Are Potential Options for Mitigating Climate Change. Agriculture, 2023;13(11):2092. Available:https://doi.org/10.3390/agriculture13112092
3. Marazzi B, Peter KE, Luciano PD, Elena C. Phylogenetic relationships within Senna (Leguminosae, Cassiinae) based on three chloroplast DNA regions: patterns in the evolution of floral symmetry and extrafloral nectaries. American Journal of Botany. 2006;93(2):288–303
4. Shivjeet S, Sandeep KS, Ashutosh Y. Review on cassia species: Pharmacological, traditional and medicinal aspects in various countries.

American Journal of Phytomedicine and Clinical Therapeutics. 2013;1:291-312
5. Kaur IA, Hmad S, Harikumar SL. Pharmacognosy, Phytochemistry and Pharmacology of Cassia occidentalis Linn; International Journal of Pharmacognosy and Phytochemical Research. 2014;6(2): 151-155.
6. Davariya VS, Vala AK. Antifunal activity of crude extract of Cassia occidentalis, International Journal of Research in Phytochemistry and Pharmacol. 2011;1 (2):36-38.
7. Emmanuel S, Rani MS, Sreekant MR. Antidiabeticactivity of Cassia occidentalis (Linn). Instreptozotocin-induced diabetic rats: dosedependentstudies.International Journal of Pharmacology and Biological Sciences. 2010;1:15-25
8. Singh PS, Salwan C, Mann AS. Evaluation of anti-diabetic activity of leaves of Cassia occidentalis. International Journal of Research in Pharmacy and Chemistry. 2011;1(4):904-913
9. Verma L, Khatri A, Kauirik B, Patil UK, Pawar RS. Antidiabetic activity of Cassia occidentalis (Linn.) in normal and alloxan-induced diabetic rats. Indian Journal of Pharmacol. 2011;42(4):224-228
10. Srinivasan D, Nathan S, Suresh T, Perumalsamy PP. Antimicrobial activity of certain Indian medicinal plant used in folkloric medicine. Journal of Ethnopharmacol. 2010;74:217-220.
11. Arya V, Yadav S, Kumar S, Yadav JP. Antimicrobial activity of *Cassia occidentalis* (L). Leaf against various Human Pathogenic Microbes, Life Sciences Medicine Research. 2010;9:1-11
12. Mazmumder MP, Percha V, Farswan M, Upaganlawar A. Cassia: A wonder gift to medical science. International Journal of Community Pharmacy. 2008;1:16-38.
13. Khalid W , Saeed F, Arshad MS, Afzaal M, Arshad MU. Senna: As immunity boosting herb against Covid-19 and several other diseases. Journal of Herbal Medicine 2023;37:1-8. 100626
14. Patil UH, Gaikwad DK. Phytochemical evaluation and bactericidal potential of Terminalia arjuna stem bark. International Journal of Pharmaceutical Sciences and Research. 2010;2(3):614-619.
15. Costa Cordeiro BMPND, Lima Santos MR, Assunção Ferreira LC, Corrêa de Araújo AR Carvalho Junior AD, Conceição Santos AP, Oliveira AG, Silva EP, Silva Falcão MT, Santos Correia JRG, Silva Almeida LCN, Silva LA, Lira Soares TH, Napoleão MV, Silva PM, Guedes Paiva. Hexane extract from Spondias tuberosa (Anacardiaceae) leaves has antioxidant activity and is an anti-Candida agent by causing mitochondrial and lysosomal damages. BMC Complementary and Alternative Medicine. 2018;18:284
16. Wadood A, Ghufran M, Jamal SB, Naeem J. Phytochemical analysis of medicinal plants occurring in local area of mardan. Analytical Biochemistry. 2013;4(2): 1-3
17. Efe M, Omwirhiren SA. James, Abass AO. The phytochemical properties and antimicrobial potentials of aqueous and methanolic seed extract of cola nitida (Vent.) and *Cola 34 cuminate* (Beauvoir) grown in South West, Nigeria. Saudi Journal of Medical and Pharmaceutical Sciences. 2016;2(12):354-363
18. Ayoola GA, Coker HA, Adesegun SA, Adepoju-Bello AA, Obaweya K, Ezennia EC, Atangbayila TO. Phytochemical Screening and Antioxidant Activities of Some Selected Medicinal Plants Used for Malaria Therapy in Southwestern Nigeria. Tropical Journal of Pharmaceutical Research. 2008;7(3):1019-1024
19. Gul R, Jan SU, Faridullah S, Sherani S, Jahan N. Preliminary phytochemical screening, quantitative analysis of alkaloids, and antioxidant activity of crude plant extracts from ephedra intermedia indigenous to Balochistan, The Scientific World Journal. 2017;7. Available:https://doi.org/10.1155/2017/587364
20. Selvakumar S, Vimalanban S, Balakrishnan G. Quantitative determination of phytochemical constituents from Anisomeles malabarica. MOJ Bioequiv 2019;6(2):19–21
21. Muhammad SA, Abubaka SM. Qualitative and quantitative determination of phytochemicals in aqueous extract of *Chrysophyllum albidum* Seed Kernel. Biosciences Biotechnology Research Asia. 2016;13(2):1201-1206.
22. Ghorai NS, Chakraborty S, Gucchait SK, Saha, Biswas S. Estimation of total Terpenoids concentration in plant tissues using a monoterpene, Linalool as standard reagent: Protocol Exchange. 2017;1-6
23. Madhu M, Sailaja V, TNVSS Satyadev, Satyanarayana MV. Quantitative phytochemical analysis of selected

medicinal plant species by using various organic solvents, Journal of Pharmacognosy and Phytochemistry. 2016;5(2): 25-29.

24. Sakulpanich A, Gritsanapan W. Extraction Method for High Content of anthraquinones from cassia fistula pods. J Health Res. 2008;22(4):167-172
25. Sulieman AE, Issa FM, Elkhalifa EA. Quantitative determination of tannin content in some sorghum cultivars and evaluation of its antimicrobial activity. Research Journal of Microbiology. 2007;2:284-28.
26. Egharevba HO, Odigwe AC, Abdullahi MS, Okwute SK, kogun JI, Phytochemical analysis and broad spectrum antimicrobial activity of *Cassia occidentalis* L. (whole plant); New York Science Journal. 2013; 3(10):74-81
27. Tamasi AA, Shoge MO, Adegboyega TT, Chukwuma EC. Phytochemical analysis and in-vitro antimicrobial screening of the leaf extract of *Senna occidentalis* (Fabaceae). Asian J Nat Prod Biochem. 2021;19:2:58-65
28. Oyun JF, Oyetayo VO. Assessment of the Preservative Efficacy of *Azadirachta indica* A. Juss. And *Psidium guajava* L. Leaf Extracts on *Capsicum annuum* L. (Bell Pepper). South Asian Journal of Research in Microbiology. 2020;7(2):19-33
29. Alkali K, Abdullahi K, Mshelia HE, Yahaya MA, Abubakar N and Tarbutu AG. Comparative Study of Antiplasdodial Activity of Aqueous Leaves Extract of *Azadirachta indica* (Juss), *Senna occidentalis* (Linn) and Standard Antimalaria on Multiplication of Plasmodium falciparum (Laveran). Research Journal of Zoology. 2018;1(3):5.
30. Abdulrazaq A, Abdulkadi B, Isyaku NT, Yahaya M, Badru OA, Adamu L, Alkali K. *In Vitro* Antimalarial activity of extracts of some indigenous plant species in Kebbi State. UMYU Journal of Microbiology Research. 2020;5(2):1- 10.
31. Daskum AM, Chessed G, Qadeer MA, Ling LY. Phytochemical screening, Gas Chromatography Mass Spectroscopy (GC-MS) and *in vitro* antiplasmodial analysis of Senna siamea leaves as antimalarial, Yobe State, Nigeria. Nigerian Journal of Parasitology. 2020;41(1):60-67.
32. Ujah II, Onyishi CK, Onovo OE. Phytochemical and vitamin constituents of Senna occidentalis Linn (Uzaki Mma). GSC Advanced Research and Reviews. 2022;11(01):011–020.
33. Nonita PP, Mylene MU. Antioxidant and cytotoxic activities and phytochemical screening of four philippine medicinal plants. Journal of Medicinal Plant Research. 2010;4:407-414.
34. Garba S, Okeniyi SO. Antimicrobial activities of total alkaloids extracted from some Nigerian Medicinal plants. J. Microbiol. Antimicrob. 2012;4(3):60-63 .
35. Ajuru MG, Williams LF, Ajuru G. Qualitative and quantitative phytochemical screening of some plants used in ethnomedicine in the Niger DeltaRegion of Nigeria. Journal of Food and Nutrition Sciences. 2017;5(5):198-205.
36. Khalid W, Saeed F, Arshad MS, Afzaal M, Arshad MU. Senna: As immunity boosting herb against Covid-19 and several other diseases. Journal of Herbal Medicine. 2023;37:1-8. 100626.
37. Mahima AK, Verma A, Kumar A, Rahal R and Deb SK. Immumomodulatary therapeutic potential of herbal, traditional and ethnovertinary medicine. Pakistan Journal of Biological Science. 2013;15: 754-774.

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