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The chemical constituents and pharmacological activities of *Cymbopagon schoenanthus*: A review

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Abstract The chemical analysis of *Cymbopogon schoenanthus* showed that it contained tannins, saponins, saponin glycosides, flavonoids, alkaloids, triterpens, balsams, cardiac glycosides, glycosides, steroids and volatile oils. The previous pharmacological effects of *Cymbopogon schoenanthus* showed that it exerted antioxidant, antimicrobial, anthelmintic, insecticidal, protective, acetylcholinesterase inhibitory activity and other pharmacological effects. This study was designed to highlight the chemical constituents and pharmacological effects of *Cymbopogon schoenanthus.*

Keywords constituents, pharmacology, *Cymbopogon schoenanthus*

Introduction

The knowledge of plant properties was acquired by ancient civilization that passed down from generation to generation until today. In the last few decades there has been an exponential growth in the field of herbal medicine. Plants generally produce many secondary metabolites which are bio-synthetically derived from primary metabolites and constitute an important source of many pharmaceutical drugs [1-32]. The chemical analysis of *Cymbopogon schoenanthus* showed that it contained tannins, saponins, saponin glycosides, flavonoids, alkaloids, triterpens, balsams, cardiac glycosides, glycosides, steroids and volatile oils. The previous pharmacological effects of *Cymbopogon schoenanthus* showed that it exerted antioxidant, antimicrobial, anthelmintic, insecticidal, protective, acetylcholinesterase inhibitory activity and other pharmacological effects. This study will highlight the chemical constituents and pharmacological effects of *Cymbopogon schoenanthus.*

Synonyms

Andropogon eriophorus Willd. *Andropogon circinnatus* Hochst. ex Steud., *Andropogon iwarancusa* subsp. Laniger, *Andropogon lanigerum* Desf., *Andropogon mascatensis* G and., *Andropogon nardoides* Nees, *Andropogon schoenanthus* var. *versicolor*, *Andropogon versicolor*, *Cymbopogon circinnatus*, *Cymbopogon schoenanthus* subsp. velutinus Cope, *Cymbopogon versicolor*, *Sorghum schoenanthus* (L.) Kuntze, *Trachypogon schoenanthus* (L.) Nees [33].

Taxonomic classification

Kingdom: Plantae; **Subkingdom**: Tracheobionta; **Superdivision**: Spermatophyta; **Division**: Magnoliophyta; **Class**: Liliopsida; **Subclass**: Commelinidae; **Order**: Cyperales; **Family**: Poaceae / Gramineae; **Genus**: *Cymbopogon*; **Species**: *Cymbopogon schoenanthus* [34].

Common Names

The word of Cymbopogon is derived from the Greek *kumbe* (boat) nd *pogon* (beard), referring to many-awned inflorescences and boat shaped spathes [35]. Common names: **Arabic**: Ethkher, Tibn Makkah, Hashishat El Gamal, Halfa Bar, Sinbel Al-Arab, Askhabar, Abo Rekba,; **English**: Camel grass, Camel hay, Geranium grass, Camel hay grass, Lemon-scented grass, Sweet cane, Sweet rush, Spikenard oil; **French** : Herbe des chameaux, Herbe à Chameau Citronnelle de Madagascar; **Hindi**: Aghin ghās, Agiyā ghās, Atigandha, Bujina, Buraro, Gandhel, Gandh-bel Mirchiagand, Palakhari, Rohisha, Rousaghas, Rusaghas, Saundhiya, Sugani, **Portuguese**: Capim-cheiroso (Brazil), Capim-cidreira (Brazil), Capim-cidrilho, Capim-ciri, Capim-de-cheiro, Capim-limão; **Spanish**: Pasto de camellos; **Swedish**: Kamelgräs [36].

Distribution

It was native to tropical Asia especially India. However, it was distributed in **Asia (**Iraq, Oman, Saudi Arabia and Yemen) and **Africa** (Algeria, Egypt, Libya, Morocco, Chad, Djibouti, Ethiopia, Somalia, Sudan, Kenya, Benin, Burkina Faso, Ghana, Guinea, Mali, Mauritania, Niger, Nigeria, Senegal and Togo) [36].

Description

Densely tufted perennial; culms erect, 60-130 cm high, enclosed at the base by tight bundles of old sheaths. Leaf-blades narrowly linear to filiform, up to 30 cm long, 1-3 mm wide, glaucous, asperulous. Spathate panicle oblong, 10-40 cm long; racemes 1-3 cm long, rachis-internodes and pedicels conspicuously white-woolly with hairs 3-4 mm long; pedicel of homogamous pair inflated, barrel-shaped, the lower raceme-base very short, about 1/3 as long as the pedicel. Sessile spikelets narrowly lanceolate, 4-7 mm long; lower glume chartaceous, concave between the keels, glabrous or pubescent throughout, unwinged; upper lemma bidentate, the lobes up to 1/3 length of lemma body; awn 4.5-9 mm long, scarcely geniculate, the column weakly defined. Pedicelled spikelet 4-7 mm long [37].

Traditional Uses

Cymbopogon schoenanthus was an aromatic herb consumed in salads and used to prepare traditional meat recipes [38]. The plant was used in traditional medicine as antihelminthes, antidiarrhea, antirheumatic, carminative, diaphoretic, stomachic, diuretic, emenagogue, antipyretic, for treatment of jaundice and as tonic. It was also used for anorexia; astringent, sudorific and to cure dromedary wounds. In Morocco and Egypt an infusion of the flowers and the whole plant were used as febrifugal, diuretic, antirheumatismal and antigastralgic [39-40]. The plant was used in Sudan for the treatment of gout, prostate inflammation, kidney diseases, and for stomach pains [41].

Parts Used: Aerial parts of the plant are used dried, powdered, or fresh [37]**.**

Physicochemical characteristics

The physicochemical characteristics of the aerial parts of *Cymbopogon schoenanthus* were: moisture: 20 %, total ash: 10 %, acid insoluble ash: 8 %, sulfated ash: 4.8 %. *Cymbopogon schoenanthus* volatile oils characteristics: colour: light yellow to brownish-yellow, appearance: mobile liquid, odour: strong lemon-like odour, specific gravity 20 °C: 0.869 - 0.904, and refractive index 20 °C: 1.478 - 1.500 [42-43].

Chemical Constituents

Chemical analysis showed that *Cymbopogon schoenanthus* contained tannins, saponins, saponin glycosides, flavonoids, alkaloids, triterpens, balsams, cardiac glycosides, glycosides, steroids and volatile oils [44-45].

The chemical composition of the essential oils of *Cymbopogon schoenanthus* was investigated by GC and GC/MS. The major constituents were found to be 2-undecanone (14.68 %) and limonene (19.54 %). However, citral (3,7-dimethyl-2,6-octadien-1-al) was one of the main constituents of many different species of lemongrass [46-48].

The essential oil of *Cymbopogon schoenanthus* of Burkina Faso contained compounds belong to the two classes regularly met in essential oils: the mono ones and sesquiterpenes. However, proportion of monoterpenes (53.2 %)

was higher than that of sesquiterpenes (12 %). Among the identified compounds two monoterpenes (the piperitone and d-2-carene) were the principal components in the essential oil [49].

Essential oils of *Cymbopogon schoenanthus* were analysed by GC–mass spectrometry and ^{13}C NMR. The major components were limonene (10.5–27.3 %), *β*-phellandrene (8.2–16.3 %), *δ*-terpinene (4.3–21.2 %) and α-terpineol (6.8–11.0 %) [38].

However, Ketoh mentioned that *Cymbopogon schoenanthus* essential oil consist of 11 compounds: carene-2 32.57 %, limonene 0.2 %, cis-pinene hydrate 1.1 %, trans-pinene hydrate 0.6 %, terpineol 1.04 %, piperitone 61.01 %, caryophyllene 1.04 %, elemol 1.07 %, caryophyllene oxide 0.46 %, γ-eudesmol 0.48 % and β-eudesmol 0.43 % [50].

Bothon1 *et al.,* found that the essential oils of *Cymbopogon schoenanthus* contained 30 compounds: 4-hydroxy-4-methyl-pentan-2-one 0.1 %, dehydro-1,8-cineole 0.1 %, δ-2-carene 11.5 %, α-phellandrene 0.1 %, p-cymene 0.1 %, limonene 2.2%, (Z) β-ocimene 0.1%, (E) β-ocimene 0.1%, fenchone 0.1%, *cis*-p-menth-2-en-1-ol 0.9%, *trans*-p-menth-2-en-1-ol 0.6 %, p-mentha-1,5-dien-8-ol 1.3 %, α-terpineol 1.3 %, *trans*-piperitol 0.3 %, nerol 0.1 %, carvotanacetone 0.4 %, piperitone 68.4 %, β-elemene 0.3 %, β-caryophyllene 0.1 %, germacrene-D 0.1 %, β-selinene 0.1 %, viridiflorene 0.1 %, germacrene-A 0.2 %, γ-cadinene 0.1 %, δ-cadinene 0.2 %, elemol 3.9 %, caryophyllene oxide 0.4 %, γ-eudesmol 0.3 %, epi-α-cadinol 0.2 % and α-eudesmol 4.9 % [51].

Cymbopogon schoenanthus also contained flavonoids such as tricin, flavones C-glycosides, luteferol and apigiferol [52].

Cymbopogon schoenanthus minerals content at early bloom stage/ dry matter, were included Ca: 0.38 %, P: 0.013 %, K: 0.56 %, Mg: 0.036%, Cu: 17.5 ppm, Zn: 11.0 ppm , Mn: 6.5 ppm and Co: 0.011 ppm. While contents of minerals at maturity stage/ dry matter were Ca: 0.49 %, P: 0.032%, K: 0.48 %, Mg: 0.022 %, Cu: 23.0 ppm, Zn: 3.5 ppm , Mn: 2.7 ppm and Co: 0.023 ppm [53].

Pharmacological effects

Antioxidant effect

The antioxidant activity of the essential oils from fresh leaves, dried leaves and roots of *Cymbopogon schoenanthus* was assayed using β-carotene–linoleic acid bleaching method. The best results (IC_{50} = 0.47 ± 0.04 mg/ ml) were obtained with the fresh leaves of plants collect in the desert region in southern Tunisia [38].

Aqueous extract, proanthocyanidin rich extract, and organic extracts of *Cymbopogon schoenanthus* shoots from three different locations in south Tunisia were screened for their antioxidant activity. Antioxidant activity measured by DPPH assay showed that the proanthocyanidin extract exhibited higher antioxidant activity than the aqueous extract. Extract concentration providing 50% inhibition (IC_{50}) ranged from 16.4±6.8µg/ml to 26.4±6.8µg/ml. The antioxidant activity was also determined using the β-carotene/linoleic acid bleaching test. The best results (IC_{50} =0.11±0.10mg/ml) were obtained with the proanthocyanidin extract of the plants collected from the desert region (Dhibat) in Tunisia [54].

Antioxidant activity of the essential oils of *Cymbopogon schoenanthus* was measured by DPPH assay. The results of antioxidant effect ranged from 36.0% to 73.8% (2 µl of essential oil per ml of test solution) [38].

Acetylcholinesterase Inhibitory Activity

The acetylcholinesterase inhibitory activity of the essential oils from fresh leaves, dried leaves and roots of *Cymbopogon schoenanthus* was investigated. The greatest acetylcholinesterase inhibitory activity (IC_{50}= 0.26 ± 0.03 mg/ml) was exhibited by the essential oil of the fresh leaves from the mountain region in southern Tunisia [38].

Aqueous extract, proanthocyanidin rich extract, and organic extracts of *Cymbopogon schoenanthus* shoots from three different locations in south Tunisia were screened for acetylcholinesterase inhibitory activity. The greatest acetylcholinesterase inhibitory activity (IC_{50} =0.23±0.04 mg/ml) was exhibited by the ethyl acetate and methanol extracts of the plants collected from the mountainous region in Tunisia [54].

Antimicrobial Effect

Aqueous extract, proanthocyanidin rich extract, and organic extracts of *Cymbopogon schoenanthus* shoots from three different locations in south Tunisia were screened for antimicrobial activity. The proanthocyanidin extracts showed a good antimicrobial activity against *Streptococcus sobrinus* at low concentration (MIC=4mg/ml) [54].

Ethanol and chloroform extract of the plant were active against *Escherichia coli* and *Staphylococcus aureus*. However, ethanol extract was more active against *Escherichia coli*, while chloroform extract was more active against *Staphylococcus aureus* [44].

However, the aerial parts extract of *Cymbopogon schoenanthus* showed activity against *Staphylococcus aureus, Bacillus subtilis, Escherichia coli* and *Pseudomonas aeruginosa* [42].

The antimicrobial activity of *Cymbopogon schoenanthus* was evaluated against three pathogenic bacteria (*Staphylococcus aureus* MARSA, *Escherichia coli* and *Salmonella typhi*) and five common fungal species (*A. flavus, A. niger, C. spicifer, F. dimerum, M. circinelloides*), four crop threatening pathogenic fungi, (*Alternaria alternata*, *Cochliobolous spicifer*, *Stachybotrys atra* var microspora, and *Ulocladium botrytis*), as well as dermatophytic fungi (*Candida albicans*, *Candida tropicalis*, *Candida krusei*, *Epidermophyton floccosum*, *Trichophyton rubrum*, *Trichophyton mentagrophytes*, *Trichophyton verrucosum* and *Microsporium canis*). The aqueous extract of *Cymbopogon schoenanthus* showed antimicrobial activity against the tested fungi and bacteria while *F. dimerum, U. botrytis, C. albicans, C. tropicalis, E. floccosum* and *M. canis* tolerated the aqueous extracts. The organic extracts (methanol, ethylacetate and n-butanol) were more effective than the aqueous extract, they showed higher antifungal activity against the tested fungi, but *A. flavus, F. dimerum, S. atra var. microspora, C. albicans, C. tropicalis, C. krusei, E. floccosum, M. canis, T. rubrum* and *T. verrucosum* tolerated these extracts. Organic extraction of *Cymbopogon schoenanthus* showed high antibacterial activity against all the tested pathogenic bacteria (*Staphylococcus aureus* MARSA, *Salmonella typhi* and *Escherichia coli*) [55].

Protective effect

The preventive potential of ethanol extract of *Cymbopogon schoenanthus* (CSEE) was studied against stress disorders at *in vitro* and *in vivo* levels. It was evaluated in H_2O_2-induced cytotoxicity in mice and stress in human neuroblastoma SH-SY5Y cells. Daily oral administration of 100mg/kg and 200mg/kg CSEE was conducted to mice for 2 weeks. It was resulted in a significant decrease of immobility time in forced swimming and tail suspension tests. The effect of CSEE on animal behavior was concordant with a significant regulation of blood serum corticosterone and cerebral cortex levels of catecholamine (dopamine, adrenaline, and noradrenaline). The results also demonstrated that pretreatment of neuroblastoma SH-SY5Y cells with CSEE at 1/2000, 1/1000, and 1/500 v/v dilutions, significantly inversed H_2O_2-induced neurotoxicity. Moreover, CSEE treatments significantly reversed heat shock protein expression in heat-stressed HSP47-transformed cells (42 °C, for 90 min) and mRNA expression of HSP27 and HSP90 in H_2O_2-treated SH-SY5Y [56].

The effects of *Cymbopogon schoenanthus* was investigated in experimental induced kidney stones in male Wistar albino rats. Oxalate nephrotoxicity was experimentally induced by 200 mg single dose of glycolic acid given orally (gavage). The rats were divided into three groups: positive control (glycolic acid), test (glycolic acid plus *Cymbopogon schoenanthus*), and negative control (drinking water). Urine analysis of blood urea nitrogen (BUN), creatinine, and calcium revealed significant differences in induction group compared to control. In addition, significant pathological changes were found in the kidney revealed by histopathological studies. Daily oral treatment with the *Cymbopogon schoenanthus* (1 ml of the extract) significantly corrected the incidence of nephrotoxicity (BUN, creatinine and calcium level differences). Moreover, a highly potent diuretic activity was recorded for *Cymbopogon schoenanthus*. After three days of experiments, five treated rats with the glycolic acid only died. The rest of animal survived and looked healthy. The authors concluded that the *Cymbopogon scheonanthus* extract has prophylactic effect in oxalate stone formation [57].

Anthelmintic and insecticidal effects

The anthelmintic potential of *Cymbopogon schoenanthus* essential oil was evaluated in lambs experimentally infected with *Haemonchus contortus*. Two-month-old lambs with mean body weight (BW) of 22.5 kg were

experimentally infected with a multidrug-resistant *Haemonchus contortus* strain. Infected animals were dosed orally with *Cymbopogon schoenanthus* essential oil. Eighteen animals were allocated into three groups of six animals, and each received one of the following treatments: Group 1-control (10 ml of water), Group 2-*Cymbopogon schoenanthus* essential oil (180 mg/kg bw); and Group 3-*Cymbopogon schoenanthus* essential oil (360 mg/kg bw). Animals received the oil once a day for 3 consecutive days. Lambs were evaluated clinically for blood biochemistry before and at 1, 5, 10, 15, 20 days after treatment. No statistically significant reduction in fecal egg count, packed cell volume or total worm count was observed after treatments. Also, no statistical difference among group means for blood levels of urea, creatinine, albumin, alkaline phosphatase, aspartate aminotransferase and gamma glutamyl transferase was found. Larval development assay (LDA) and egg hatch assay (EHA) were performed from feces of treated animals at 1, 5, 10 and 15 days after essential oil administration. An inhibition in LDA was observed 1 day after the 3-day treatment in larvae from feces of animals treated with 360 mg/kg essential oil [58].

Cymbopogon schoenanthus essential oils were evaluated against developmental stages of trichostrongylids from sheep naturally infected (95% *Haemonchus contortus* and 5% *Trichostrogylus* spp.) using egg hatch assay (EHA), larval development assay (LDA), larval feeding inhibition assay (LFIA), and larval exsheathment assay (LEA). *Cymbopogon schoenanthus* essential oil showed a good activity against ovine trichostrongylids. It had LC_{50} value of 0.045 mg/ml in EHA, 0.063 mg/ml in LDA, 0.009 mg/ml in LFIA, and 24.66 mg/ml in LEA [59].

The insecticidal activity of crude essential oil extracted from *Cymbopogon schoenanthus* and its main constituent (piperitone), was assessed on different developmental stages of *Callosobruchus maculatus*. Piperitone was more toxic to adults with LC_{50} value of 1.6 microl/l vs. 2.7 microl/l obtained with the crude extract. Piperitone inhibited the development of newly laid eggs and of neonate larvae, but was less toxic than the crude extract to individuals developing inside the seeds [50].

Cymbopogon schoenanthus essential oils from Benin Republic in west Africa displayed about 100% mortality rate against adult *Anopheles gambiae* [60].

The efficacies of essential oils of nine plant species, which were traditionally used to avoid mosquito bites in Benin, were investigated. These oils were tested on suceptible "kisumu" and resistant "ladji-Cotonou" strains of *Anopheles gambiae*. The results showed that *Cymbopogon schoenanthus* was a potential promising plant sources alternative to pyrethroids, for the control of the *Anopheles malaria* vector in Benin. The efficacy of essential oil was possibly attributed to its chemical composition in which major and/or minor compounds have been shown insecticidal activities on various pests and disease vectors such as Anopheles [61].

The effect of camelgrass (*Cymbopogon schoenanthus*) oil on Anopheles mosquito and its larvae was tested to evaluate its repellence property. Different quantity of the oil extract viz: 10ml, 5ml and 1ml was introduced into two set of twelve beakers each containing twenty larvae and adult mosquito. Mortality rate was recorded at certain time interval. Application of the oil extract on adult mosquitoes and larvae caused 100% mortality. The maximum mortality time taken was 15 minutes for the adult mosquito and 18 minutes for the larvae. The minimum mortality time taken was 3 minute. The rapid mortality recorded in respect to both larvae and adult of anopheles mosquito indicated high insecticidal and larvicidal properties of the chemical compounds present in the oil of the grass species [62].

The efficacy of 3% citronella candles and 5% citronella incense were evaluated in protecting subjects from bites of Aedes spp under field conditions. The study was conducted in a deciduous woodlot in Guelph, Ontario, Canada. Eight subjects, dressed identically, were assigned to one of 8 positions on a grid within the study area. Two citronella candles, 2 citronella incense, 2 plain unscented candles, or no candles (i.e., non-treated controls) were assigned to 2 positions on the grid each evening. Subjects conducted 5-min biting counts at each position and performed 16 biting counts per evening. On average, subjects received 6.2 ± 0.4, 8.2 ± 0.5, 8.2 ±0.4, and 10.8 ± 0.5 bites/ 5 min at positions with citronella candles, citronella incense, plain candles, and no candles, respectively. Although significantly fewer bites were received by subjects at positions with citronella candles and incense, than at non-treated locations, the overall reduction in bites provided by the citronella candles and incense was only 42.3 and 24.2%, respectively[(63)].

The insecticidal properties of the aerial part of *Cymbopogon schoenanthus* was studied experimentally. Cabbage plants were sprayed with the aqueous extracts of *Cymbopogon schoenanthus* leaves as treatment, and the damage levels of *Plutella xylostella* was assessed. *In vitro*, the emulsified essential oil concentrations were used in a contact test on the larvae in order to assess the mortality effects. The larvae survival time was only 22 seconds with *Cymbopogon schoenanthus* emulsified oil treatment (2 g/l), whilst it exceeded 44,100 seconds (over 12 hours) for the dimethoate. The nutrition test showed that at 48 h period, a significant effectiveness against larvae was observed with emulsified oil treatment 2 g/l (60% mortality) versus 10% of mortality for dimethoate. The authors concluded that *Cymbopogon schoenanthus* can validly be used as alternative in *P. xylostella* management. The results of the field experiments showed no significant difference between the treatments and the control in terms of marketable cabbages harvested [64].

Toxicity and contra-indications

The geraniol, the main constituent (59%) of *Cymbopogon schoenanthus* oils has an oral LD_{50} in rats of 3600 mg/kg, and geranial (13%), the second main constituent has an oral LD_{50} in rats of 4960 mg/kg [43, 58].

Because of a lack of clinical data, lemongrass was not recommended for pregnant or lactating women without a physician's recommendation, however some reports mentioned that lemongrass should not be used in pregnancy because of uterine and menstrual flow stimulation. Lemongrass allergies and sensitivity have also been found in persons with grass and citrus allergies and/or sensitive skin. However, as clinical studies report no adverse allergenic effects from lemongrass tea. Extended use of lemongrass was suspected to interfere with liver function though clinical data does not clearly supported (nor disproved) this [65].

Dose

There was no proven safe or effective dose of lemongrass for adults. Traditionally, 1-2 teaspoons of lemongrass in six ounces of boiling water has been taken by mouth as a tea. Two grams of lemongrass herb, cut and powdered into one cup of boiling water, has also been taken by mouth. 140 milligrams of lemongrass oil in a capsule once a day for 90 days were used by mouth in hyperlipidemic patients. For thrush, half a packet (12.5 milliliters) of dried lemongrass was used to make an infusion with 500 milliliters of boiling water. The infusion was boiled for 10 minutes and cooled. For the first treatment, patients drank 125 milliliters of lemongrass infusion and then drank 250 milliliters twice a day for a total of 10 days (a fresh infusion was made every 24 hours) [66].

Conclusion

This review discusses the chemical constituent, pharmacological and therapeutic effects of *Cymbopogon schoenanthus* as promising herbal drug because of its safety and effectiveness.

References

[1]. Al-Snafi AE. Clinically tested medicinal plant: A review (Part 1). SMU Medical Journal 2016; 3(1): 99-128.
[2]. Al-Snafi AE. Chemical constituents and pharmacological effects of *Clerodendrum inerme*- A review. SMU Medical Journal 2016; 3(1): 129-153.
[3]. Al-snafi AE. Chemical constituents and pharmacological effects of *Citrullus colocynthis* - A review. IOSR Journal of Pharmacy 2016; 6(3): 57-67.
[4]. Al-Snafi AE Medical importance of *Cichorium intybus* – A review IOSR Journal of Pharmacy 2016; 6(3): 41-56.
[5]. Al-Snafi AE. Pharmacological importance of *Clitoria ternatea* – A review IOSR Journal of Pharmacy 2016; 6(3): 68-83.
[6]. Al-Snafi AE. The medical Importance of *Cicer arietinum* - A review IOSR Journal of Pharmacy 2016; 6(3): 29-40.
[7]. Al-Snafi AE. Medical importance of *Antemis nobilis* (*Chamaemelum nobilis*)- A review. Asian Journal of Pharmaceutical Science & Technology 2016; 6(2): 89-95.

[8]. Al-Snafi. AE. *Adonis aestivalis*: pharmacological and toxicological activities- A review. Asian Journal of Pharmaceutical Science & Technology 2016; 6(2): 96-102.
[9]. Al-Snafi AE. Chemical constituents and pharmacological importance of *Agropyron repens* – A review. Research Journal of Pharmacology and Toxicology 2015; 1 (2): 37-41.
[10]. Al-Snafi AE. The pharmacological activities of *Cuminum cyminum* - A review. IOSR Journal of Pharmacy 2016; 6(6): 46-65.
[11]. Al-Snafi AE. Medical importance of *Cupressus sempervirens*- A review. IOSR Journal of Pharmacy 2016; 6(6): 66-76.
[12]. Al-Snafi AE. The contents and pharmacology of *Crotalaria juncea*- A review. IOSR Journal of Pharmacy 2016; 6(6): 77-86.
[13]. Al-Snafi AE. The medical importance of *Cydonia oblonga*- A review. IOSR Journal of Pharmacy 2016; 6(6): 87-99.
[14]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of plants with antifungal activity (part 1). Int J of Pharm Rev & Res 2015; 5(3):321-327
[15]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of their respiratory effects (part 1). International Journal of Pharmacological Screening Methods 2015; 5(2):64-71.
[16]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of plants with hypolipidemic, hemostatic, fibrinolytic and anticoagulant effects (part 1). Asian Journal of Pharmaceutical Science & Technology 2015; 5(4): 271-284.
[17]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of their effect on reproductive systems (part 1). Ind J of Pharm Sci & Res 2015; 5(4): 240-248.
[18]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of their dermatological effects (part 1). Int J of Pharm Rev & Res 2015; 5(4):328-337.
[19]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of plants with anticancer activity (part 1). Int J of Pharmacy 2015; 5(3): 104-124.
[20]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of plants with anti-inflammatory, antipyretic and analgesic activity (part 1). Int J of Pharmacy 2015; 5(3): 125-147.
[21]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of their immunological effects (part 1). Asian Journal of Pharmaceutical Research 2015; 5(3): 208-216.
[22]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of their antibacterial activity (part 1). International Journal of Pharmacology and Toxicology 2015; 6(3): 137-158.
[23]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of plants with antioxidant activity (part 1). International Journal of Pharmacology and Toxicology 2015; 6(3): 159-182.
[24]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of their antiviral activity (part 1). International Journal of Pharmacological Screening Methods 2015; 5(2): 72-79.
[25]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of plants with cardiovascular effects (part 1). Int J of Pharmacology & Toxicology 2015; 5(3): 163-176.
[26]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of medicinal plants with central nervous effects (part 1). Int J of Pharmacology & Toxicology 2015; 5(3): 177-192.
[27]. Al-Snafi AE. Therapeutic properties of medicinal plants: a review of their detoxification capacity and protective effects (part 1). Asian Journal of Pharmaceutical Science & Technology 2015; 5(4): 257-270.
[28]. Al-Snafi AE. Medicinal plants with anti-urolithiatic effects (part1). Int J of Pharmacy 2015; 5(2): 98-103.
[29]. Al-Snafi AE. Galactagogue action of the crude phenolic extracts of grape seeds (*Vitis vinifera*). International Journal of Biological & Pharmaceutical Research 2015; 6(8): 577-580.
[30]. Al-Snafi AE. Mammary gland stimulating effects of the crude phenolic extracts of green tea (*Camellia sinensis*). International Journal of Biological & Pharmaceutical Research 2015; 6(7): 573-576.
[31]. Al-Snafi AE. The chemical constituents and pharmacological importance of *Chrozophora tinctoria*. Int J of Pharm Rev & Res 2015; 5(4): 391-396.

[32]. Al-Snafi AE, Allahwerdi, IY. and Jawad IA. Using of topical 5% urtica dioica ointment in treatment of psoriasis. European Journal of Biomedical and Pharmaceutical Sciences 2015; 2(4):103-111.
[33]. The Plant List, The working list of plant species. http://www.theplantlist. org/tpl1.1/record/kew-406274
[34]. United State Department of Agriculture, Natural resources conservation service. Cymbopogon schoenanthus , http://plants.usda.gov/java/ClassificationServlet? source =display&classid=CYSC8
[35]. Watson L and Dallwitz M. The grass genera of the world, Cymbopogon Spreng. http://delta-intkey.com/grass/www/cymbopog.htm [2nd April 2015].
[36]. USDA, ARS, National Genetic Resources Program. Germplasm Resources Information Network-(GRIN). National Germplasm Resources Laboratory, Beltsville, Maryland. URL: http://www.ars-grin.gov.4/cgi-bin/npgs/ html/taxon.pl?3309 (16 October 2015)
[37]. Rizk A. The phytochemistry of the flora of Qatar. University of Qatar, Doha, Qatar, Scientific and Applied Research Centre 1986.
[38]. Khadri A, Serralheiro MLM, Nogueira JMF, Smiti A and Araujo MEM. Antioxidant and antiacetylcholinesterase activities of essential oils from *Cymbopogon schoenanthus* L *Spreng*. Determination of chemical composition by GC–mass spectrometry and ^{13}C NMR. Food Chemistry 2008; 109(3): 630-637.
[39]. Atyat A. Production and processing of medical and aromatic plants in the Arab world. Arab Institution for Studies and Publishing, Beirut 1995.
[40]. A Guide to medicinal plants in north Africa. *Cymbopogon schoenanthus*. IUCN Centre for Mediterranean Cooperation, 2005: 21-22.
[41]. El Ghazali GEB, El tohami MS, El Egami AAB, Abdalla WS and Mohamed MG. Medicinal plants of the Sudan. Medicinal plants of Northern Kordofan, Omdurman. Islamic University press, Omdurman 1997.
[42]. EL-Kamali HH and EL-amir MY. Antibacterial activity and phytochemical screening of ethanolic extracts obtained from selected Sudanese medicinal plants. Current Research Journal of Biological Sciences 2010; 2(2): 143-146.
[43]. Material safety data sheet, Lemongrass oil , http://www.essentialoilsdirect.co.uk/ lemongrass-cymbopogon_citratus-essential_oil.html
[44]. Mohammad Ali RM. Antibacterial and phytochemical screening *Lepidium sativum* and *Cymbopogon schoenanthus.* BSc thesis, Faculty of Science, Khartoum University 2012.
[45]. Amina RM, Aliero BL and Gumi AM. Phytochemical screening and oil yield of a potential herb, camel grass (*Cymbopogon schoenanthus* Spreng). Cent Euro J Exp Bio 2013; 2 (3):15-19.
[46]. Shahi AK and Taya A. Essential oil composition of three *Cymbopogon* species of Indian Thar Desert. Journal of Essential Oil Research 1993;5(6), http://openagricola. nal.usda.gov/Record/IND20386236
[47]. Banthorpe DV, Duprey RJ, Hassan M, Janes JF and Modawi BM. Chemistry of the Sudanese flora. I. Essential oils of some cymbopogon species. *Planta Med* 1976; 29(1): 10-25.
[48]. Wilson ND, Ivanova MS, Watt RA and Moffat AC. The quantification of citral in lemongrass and lemon oils by near-infrared spectroscopy. *J Pharm Pharmacol* 2002; 54(9):1257-1263.
[49]. Yentema O, Alioune O and Dorosso SA. Chemical composition and physical characteristics of the essential oil of *Cymbopogon schoenanthus* (L.) Spreng of Burkina Faso. Journal of Applied Sciences 2007; 7(4): 503.
[50]. Ketoh G. Comparative effects of *Cymbopogon schoenanthus* essential oil and piperitone on *Callosobruchus maculatus* development. Fitoterapia 2006; 77(7-8): 506-510.
[51]. Bothon FTD, Gnanvossou D, Noudogbessi1 JP, Hanna R and Sohounhloue D. *Bactrocera cucurbitae* response to four *Cymbopogon* species essential oils. Journal of Natural Products 2013; 6: 147-155.
[52]. Heiba HI and Rizk AM. Constituents of *Cymbopogon* Species. Qatar Univ Sci Bull 1986; 6: 53-75.

[53]. Sultan JI, Inam-ur-Rahim Nawaz H, Yaqoob M and Javed I. Mineral composition, palatability and digestibility of free rangeland grasses of northern grasslands of Pakistan. Pak J Bot 2008; 40(5): 2059-2070.

[54]. Khadri A, Neffati M, Smiti S, Falé P, Rosa A, Lino L, Luisa M, Serralheiro M, Eduarda M and Araújo M. Antioxidant, antiacetylcholinesterase and antimicrobial activities of *Cymbopogon schoenanthus* L. Spreng (lemon grass) from Tunisia. LWT - Food Science and Technology 2010; 43(2): 331-336.

[55]. Sabry A, El-Zayat SA, El-Said1 AHM, Abdel-Motaal FF and Magraby TA. Mycoflora associated with Halfa-bar leaves and stems (*Cymbopogon schoenanthus* L. Spreng), *in vitro* the antimicrobial activity of the plant leaves and stems secondary metabolites. Int J Curr Microbiol App Sci 2014; 3(2): 874-882.

[56]. Othman MB, Han J, El Omri A, Ksouri R, Neffati M and Isoda H. Antistress effects of the ethanolic extract from *Cymbopogon schoenanthus* growing wild in Tunisia. Evidence-Based Complementary and Alternative Medicine 2013; http://dx. doi.org/10.1155/2013/737401

[57]. Al Haznawi AM, Attar AS, Abdulshakoor AA and Ramadan MA. Inhibition of calcium oxalate nephrotoxicity with *Cymbopogon schoenanthus* (Al-Ethkher). MSc thesis. Faculty of Applied Medical Sciences, Saudi Arabia 2007.

[58]. Katiki LM, Chagas AC, Takahira RK, Juliani HR, Ferreira JF and Amarante AF. Evaluation of *Cymbopogon schoenanthus* essential oil in lambs experimentally infected with *Haemonchus contortus*. Vet Parasitol 2012; 186(3-4): 312-318.

[59]. Katiki LM, Chagas AC, Bizzo HR, Ferreira JF and Amarante AF. Anthelmintic activity of *Cymbopogon martinii*, *Cymbopogon schoenanthus* and *Mentha piperita* essential oils evaluated in four different *in vitro* tests. Vet Parasitol 2011; 183(1-2): 103-108.

[60]. Nonviho G, Wotto VD, Noudogbessi J, Avlessi F, Akogbeto M and Sohounhloué DC. Original research paper insecticidal activities of essential oils extracted from three species of poaceae on *Anopheles gambiae* spp, major vector of malaria. Sci Study Res 2010; 11: 411-420.

[61]. Bossou AD, Mangelinckx S, Yedomonhan H, Boko PM, Akogbeto MC, Kimpe ND, Avlessi F and Sohounhloue DCK. Chemical composition and insecticidal activity of plant essential oils from Benin against *Anopheles gambiae* (Giles). Parasites & Vectors 2013; 6: 337-353.

[62]. Musa AR, Aleiro BL, Aleiro AA and Tafinta YI. Larvicidal and insecticidal effect of camelgrass (*Cymbopogon schoenanthus*) oil on Anopheles mosquito. Annals of Biological Sciences 2014; 2 (1):19-22.

[63]. Lindsay RL, Surgeoner GA, Heal JD and Gallivan GJ. Evaluation of the efficacy of 3% citronella candles and 5% citronella incense for protection against field populations of Aedes mosquitoes. J Am Mosq Control Assoc 1996; 12(2 Pt 1): 293-294.

[64]. Laba B, Nenonéné AY, Adjrah Y, Koba K, Poutouli W and Sanda K. Efficacy of *Cymbopogon schoenanthus* L. Spreng (Poaceae) extracts on diamondback moth damaging cabbage. J Biofertil Biopestici 2012; 3: 3-6.

[65]. Lemongrass, https://nuannaarpoq.wordpress.com/thalassas-herbal/ lemongrass/

[66]. Living Naturally, Lemongrass (Cymbopogon citratus, Cymbopogon nardus), http://www.kidswellness. com/ns/DisplayMonograph.asp?storeID=464477254e 3a4415b459127000e2b4ae&DocID=bottomline-lemongrass