# Anatomical and Phytochemical Study of *Glossostemon bruguieri* (Desf.) Sterculiaceae in Kurdistan Region of Iraq

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## Abstract

*Glossostemon bruguieri* named "ARAB QŌZI" or "MOGHAT", which is used in the traditional medicine for treatment various ailments, where no such study has been conducted so far. This investigations report for the first time the anatomical characters and identify the chemical constituents of methanolic extract for different parts of *G. bruguieri* by using modern sensitive gas chromatography – mass spectroscopy (GC-MS).The microscopic study showed the present of internal duct in all studied parts ,also present of oil drops in the cells of root ,cells with special bodies near the vascular bundle of leaves and its petioles and the present of (Stellate, dendroid and multicellular glandular) trichome in aerial parts of the plant. GC-MS analysis revealed the presence of many compounds in different parts of *G. bruguieri* different between the parts in relation to the anatomical structure which reflex the importance of the aerial parts of the plant in addition to traditional use of root.

**Keywords:** *Glossostemon bruguier* (Moghat), anatomy, phytochemical analysis.

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**Anatomical and Phytochemical Study of *Glossostemon bruguieri* (Desf.) Sterculiaceae in Kurdistan Region of Iraq**

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**دراسة تشريحية كيمياوية للنوع (Sterculiaceae) *Glossostemon bruguieri* النامية في اقليم كوردستان العراق**

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**الخلاصة**

النوع (.Desf) *Glossostemon bruguieri* المعروف محلياً بعرب قوزي يستخدم بصورة تقليدية لعلاج العديد من الامراض مع قلة المصادر البحثية ،هذه الدراسة سجلت لأول مرة معلومات تشريحية .حددت المحتوى الكيمياوي للمستخلص الميثانولي لاجزاء مختلفة من النبات *G. bruguieri* بأستخدام كروماتوغرافيا الحالة الغازية ومطياف الكتلة الحساسة (GC-MS). الدراسة التشريحية اظهرت وجود قنوات افرازية في جميع الاجزاء المدروسة وظهور قطرات زيتية في خلايا الجذر مع وجود خلايا ذات تراكيب خاصة قرب الحزمة الوعائية للورقة واعنقها ووجود شعيرات نجمية وشجرية وغدية متعددة الخلايا في بشرة الاجزاء الهوائية. التحليل الكيمياوي باستخدام (GC-MS) للمستخلص الميثانولي كشفت عن وجود مركبات عديدة في الازهار والاوراق والنورات الزهرية والساق للنوع *G. bruguieri* مختلفة تبعا للفروقات التشريحية التي اظهرت اهمية الساق بالاضافة الى الاستخدامات التقليدية للجذر.

**كلمات مفتاحية**: *Glossostemon bruguier*، مغات ،تشريح ،تحليل كيمياوي

## Introduction

Despite that Sterculiaceae have no long reputation as medicinal plant family also no high variety of taxa, some species such as moghat (ARAB QŌZI was the common name) *Glossostemon bruguieri* which is the only native genus and species of this family in Iraq (Townsend and Evan , 1980) have a history in ethnobotany . *G. bruguieri* is native to Iraq and Iran, and was cultivated in Egypt for its edible roots a long time ago (Meselhy, 2003), distributed in Upper Jazira ,Central Alluvial Plain , Nineveh, Kirkuk and Persian foothills districts of Iraq (Townsend and Evan,1959). (Al-Rawi and Chakravarty, 1964) refers to root of *G. bruguieri* as medicinal plant with aphrodisiac uses and tonic against cough. (Ibrahim *etal*., 1997) Evaluate the content and composition of proteins and mucilage of the roots and seeds of Moghat, while (El-Sayed et al, 2004) study the Phytochemical content which show characters of new flavonoids and the effect of aerial parts of *G. bruguieri* on urine volume. (El-Kiey and Hashem, 1957) study Pharmacognostical importance of Moghat in Egypt this refer to its importance as food and medicinal additives. The structures and the Occurrence of some compound such as 4-methoxyisoscutellargin, sesamin, chrysophanol, emodin and methoxyemodin (physician) and the new compound (3‴-hydroxycupressuflavone) in Moghat reported for the first time by (Meselhy, 2003). Mucilage from *G. bruguieri* roots exerted a pronounced hypoglycemic action bringing the glucose level down to half (Eddouks and Zeggwagh, 2014). The root extract of *G. bruguieri* showed no activity at all for all tested bacteria used in study of antibacterial potentiality of some edible plant by (El-Sayed *etal*., 2014) whereas variety of antibacterial and antifungal activities of *G. bruguieri* reported by (Zain *etal*., 2014), Also mentioned by (Sher and Alyemeni, 2011) as medicinal plants used in Ethnoveterinary practices in Saudi Arabia. With these uses and interesting of this species there is no anatomical and phytochemical study of other parts of plant in compare with the limited research on root and seeds, also no data about species status, for that we investigate about structure and chemical constituents in different plant parts which make this plant to be deliberated also check about species status.

## Material and Methods

### Plant collection

Survey and checking about the species in remained studies to collection and evaluation of species status, some data obtained by traveling in the field and because of low safety in some area others data collected by contacting herbalist and botanist in referred physiographic districts in Iraq (plate 1 B), Whole parts of *Glossostemon bruguieri* were collected beside road between Kirkuk and Kalar in Kurdistan region during Jun 2015. The plant material was identified and classified by National Herbarium-Baghdad/Iraq. The collected samples were separated and packed directly in polyethylene bugs. The flower, leaf, stem and inflorescence plant parts were cut and washed with tab water in order to remove dust. The samples were dried under shade at room temperature until they reached a constant weight, and then powdered finely by using grinder machine (IKA-WERKE-M20-Germany) for 30 second. Consequently the dry plant samples were pulverized into powdered form, and stored in dark condition. Other parts preserved in F.A.A solution (Formalin, Acetic acid and Alcoholic ethanol) for anatomical study.

**Anatomical Investigation:**

The different parts of the present species was collected and preserved in F.A.A solution, cross sections prepared directly by Razor blade as hand free section or by Freezing microtome (SLEE Model *mtc*-Germany), to show different types of cells and tissue systems, samples stained with Safranin O and sometimes by logul"s solution to check about the starchy and special cells (Chemicals provided by Sharlu of Spain). Prepared sections examined by light microscope (Meiji 4300L, Japan)and some time by stereo microscope (Meiji RZ model, Japan), prepared slides documented by Canon Camera Kiss model, the specialized cells and tissues as ducts investigated in different parts of the plants.

**Preparation of methanolic extracts**

10 gm of aerial parts of plants (leaf, stem, flower and inflorescence) was extracted with methanol solvent (100 mL) by maceration extraction for 6 hours under mechanical stirring at room temperature. The procedure was repeated three times. After extraction, it was filtered and the methanol solvent was evaporated by using rotary evaporation (Laborota 4000, Heidolph Instruments, Schwabach, Germany, temperature 40-45°C). The obtained extracts were stored at room temperature for further studies.

**GC/MS Analysis**

The protocols were experimentally tested and designed ,the methanolic extraction of aerial parts of plants was analyzing by using GC-MS. Shimadzu Model QP-2010 Mass spectrometer under the following conditions: HP-5 MS (5% phenylmethylsiloxane) capillary column (30 m × 0.25 mm i.d., film thickness 0.25 µm). Inert gas of helium was used as a carrier gas at constant flow rate of 1.61ml/minute. Injection port temperature and interface temperature were set at 230 and 245°C respectively. Ion Source Temperature was 250°C. Initial column temperature was 60ºC, held for 2 minute and increased at 70ºC /min to 305ºC and held for 5 min. An electron ionization system with ionization energy 70 eV was used for the detection of compounds. 75mg of Methanol leaf extraction was taken and made up to 15 ml with methanol, from which 1µl of sample was automatically injected (split mode) in the column and mass spectral scan range was set at 45-500 amu. The split ratio was of 1:15. The mass spectrum of the unknown component was compared with the spectrum of the known components stored in the Wiley library. The name, molecular weight, and structure of the components of the test material were finally ascertained.

## Results and Discussion

**Species status and anatomical study:**

Despite that project of flora of Iraq was neglected in the last years but it has been that some plants as studied species lost it is density this may be because of over harvesting by herbalist or Egyptian people in seventeen's and eighteens of last century or because of global warming which causing elevation in atmospheric temperature as our observations since 2011 (plate 1, A ) also some area as Jabal Singar undergo flooding in different years which noticed by collagenous researchers among different sites we recorded the best one of them between kifri and Kalar city (Garmin GPS72: N 34° 43.391' E045°07.020' Elevation: 338.5). For that we suggest that the conservation status of this species at least not evaluated (NE) or me be near threatened (NT) (IUCN, 2012).

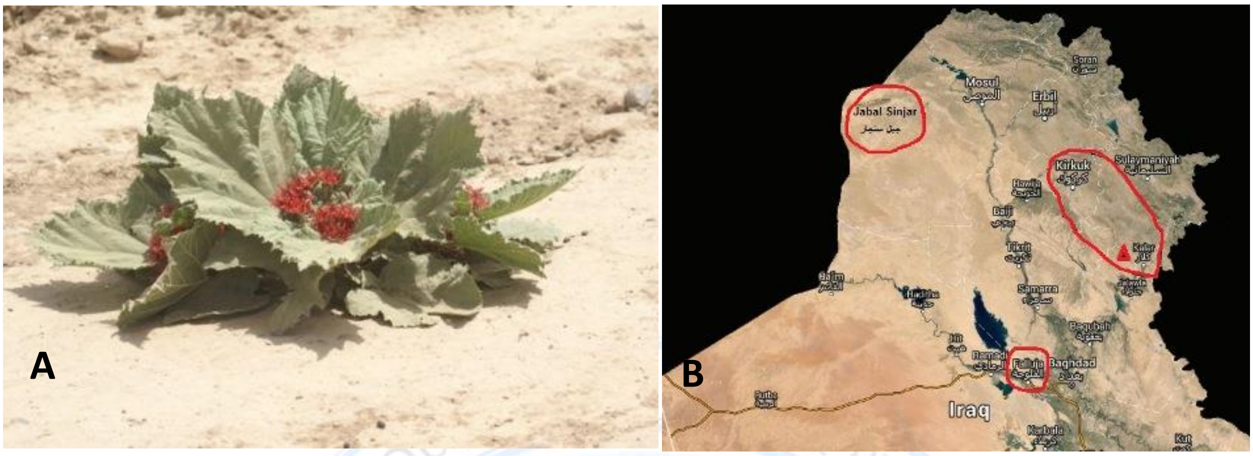
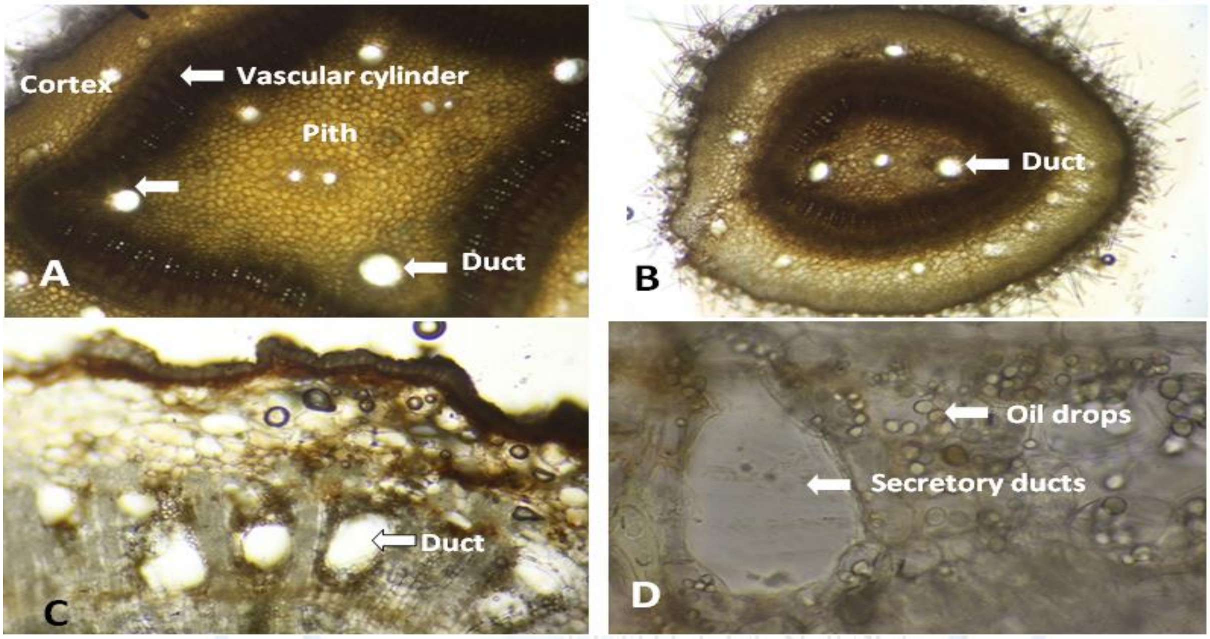
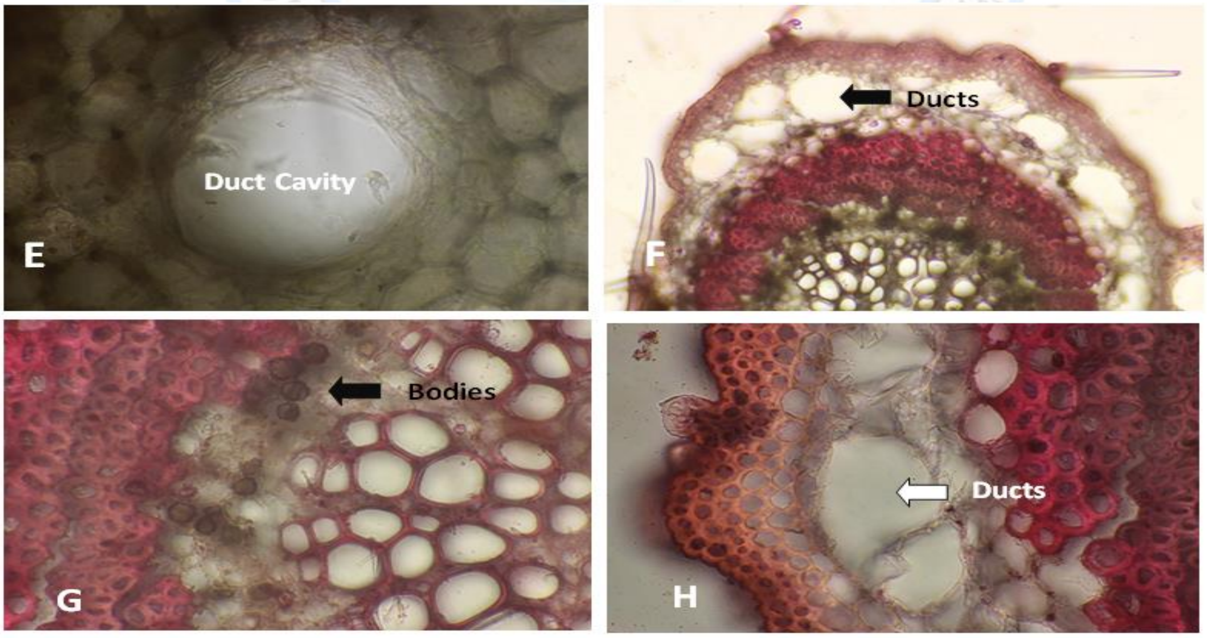



**Plate 1: Species status of *Glossostemon bruguier*: A: *G. bruguier* in field, B: Geographic distribution of *G. bruguier* as last references, ∆ site of collection.**

The anatomical characters of the different parts of *Glossostemon bruguieri* have no references, our investigation showed that (root, stem, inflorescences and leaf petiole) rich with Schizogenous secretory ducts of mucilaginous materials with differentiation in density and activity of the ducts which showed high ratio in stem (Plate 2, A) in both pith and cortex, also the cross section of stem showing irregular angular complete vascular cylinder and scattered secretory internal ducts in cortex (the smallest) and in pith (the largest) (Plate 2, E) , and the cross section of inflorescence as extension to stem showed smallest duct cavities (Plate 2,B),while the cross section of root showed a large ducts only in cortex outer the vascular bundles (Plate 2,C) which characterized by surrounding cells with oil droplets(Plate 2,D), the leaf mesophyll is isobilateral and have cells with Crystalline spherical P-protein bodies (Plate 2,L) according to (Beck, 2010) which occur clearly dark spheres outside vascular bundles in both leaf and leaf petiole (Plate 2, G), no ducts in leaf except in the cortex of leaf petiole (Plate 2, F and H), we suggest that ducts and its mucilaginous materials is the main source of phytochemicals in Moghat *Glossostemon bruguieri* in addition to oil droplets in roots and P-protein bodies of leaf and leaf petiole.The Indumentum study showed that all shoot parts covered by stellate trichome (Plate2, K) but the epidermis of stem and inflorescences contain special dendroid trichome (Plate2,I) consist of multicellular stalk and tree like branch in the top of stalk. Also the present of specialized glandular trichome (Plate 2, J) with multicellular stalk and multicellular glandular trichome this described by (Evert, 2006) and may be another source of some phytochemicals.





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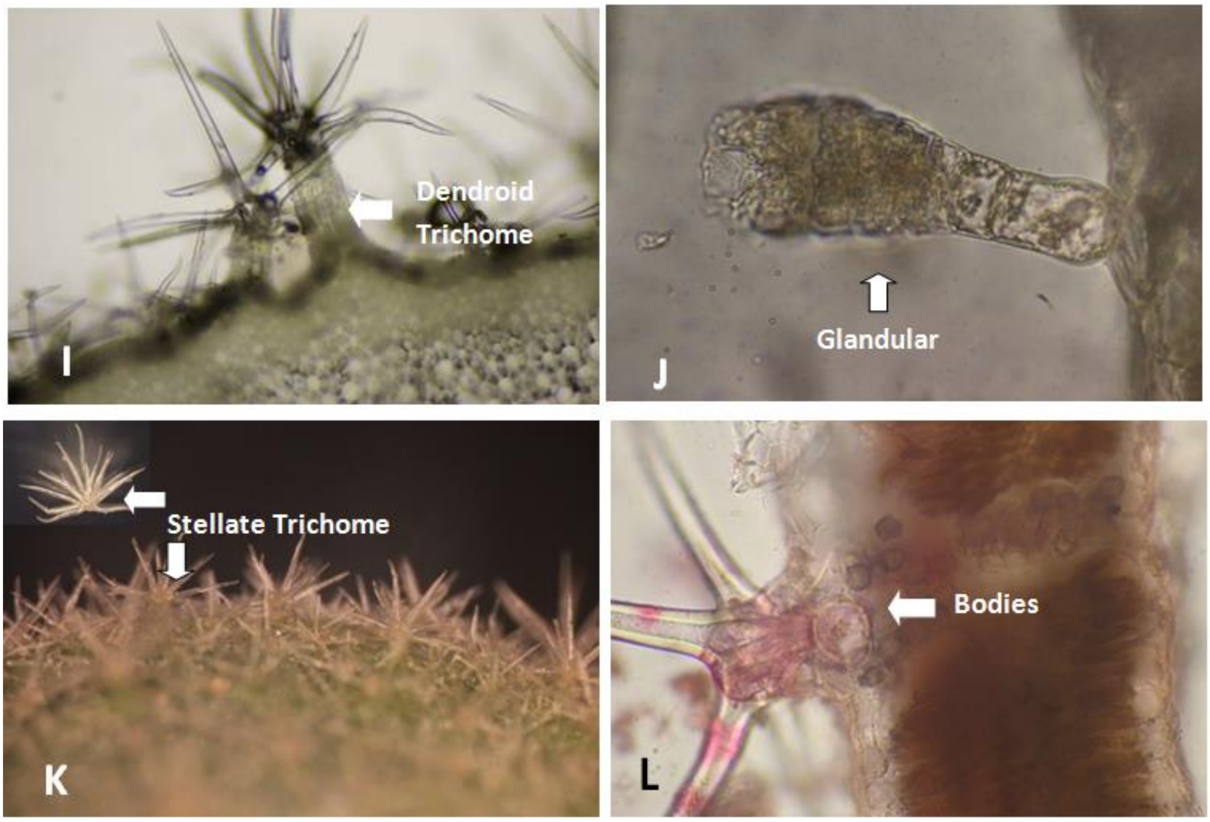


**Plate 2:** Anatomical characters of *Glossostemon bruguieri*: **A:** The cross section of stem, **B:** The cross section of inflorescence, **C:** The cross section of root, **D:** Enlargement part of the cross section of root, **E:** Enlargement section showing the duct cavity **F:** The cross section of leaf petiole, **G;** Enlargement part of section of leaf petiole showing bodies, **H:** Enlargement part of section of leaf petiole showing large duct cavity, **I:** Dendroid trichome, **J:** Specialized glandular trichome, **K:** Stellate trichome and **L:** Stellate trichome with secretory cells and some bodies in the basal cells of trichome.

### Phytochemical compounds in *G. bruguieri* leaf, stem, flower and inflorescence

Methanolic extraction was obtained by maceration extraction from the leaf, flower, stem and inflorescence of *Glossostemon bruguieri* with yields of 7.28%, 3.6%, 8.4% and 4.41% respectively. The results are obtained by Gas Chromatography and Mass Spectroscopy analyses of methanol extraction of the *G. bruguieri* (Table 1 - 4). This table showed that 50 compounds (80.82%) of flower, 43 compounds (71.09%) of inflorescence, 39 compounds (72.14%) of leaf and 55 compounds (84.76%) of stem were identified.

The number of hydrocarbon compounds in inflorescence was higher compared to other three plant parts according for 24.96% of the total amount of volatile compounds, but approximately the similar number of hydrocarbon compounds was presence in flower (10 compounds, 14.73%), leaf (10 compounds, 14.91%) and stem (8 compounds, 7.22%). Stem parts of *G. bruguieri* showed contain higher number of nitrogen compounds was 7 (2.89 %) and lower number presence in inflorescence was 1 (0.69 %), beside stem and inflorescence the number of nitrogen compounds was 3 and 5 in both leaf and flower but the proportion increased from 1.32% in leaf to 6.21% in flower. On the other hand the number of ester compounds was 3 in inflorescence and leaf but also the yield of volatile compounds deeply similar 5.17% in inflorescence to 5.21% in leaf, while 5 compounds in flower and 2 in stem with percentage ratio 9.19% and 1.98% respectively. The higher number of acid compounds was found in stem (12 compounds with ratio 10.89%) and lower number (7 compounds with ratio 6.46%) in flower while 8 and 9 compounds was presence in both inflorescence and leave with relative contribute (8.77% and 8.96%) respectively. Finally the relative proportion of alcohols compounds in flower 29.49 % and leave 28.04 % increased as compound to those in stem 25.01% and inflorescence 20.28 %, and in contrast apparent in the percentage ratio of aldehydes and ketones compounds which was 12.69% in stem, 3.45% in flower, 3.36% in inflorescence and 2.62% in leaf. The significant differences in the chemical constituents founds in these four parts provide compelling evidence that leaves, stems, flowers and inflorescences must be used in the treatment of various disease. Of the various classes of compound identified, alcohols and hydrocarbons constituted the major part in inflorescence, leaf, flower and stem. Cyclohexanol was the most abundant hydrocarbon compound in all plant parts with relative proportion 16.97% in flower, 15.04% in inflorescence, 16.72% in leaf and 14.87% in stem. Beside this compound, other major volatile compounds found in flower were, gamma.-sitosterol (6.76%), hexatriacontane (4.19%), 1-(+)-Ascorbic acid 2,6-dihexadecanoate (2.80%), Tetradecyl trifluoroacetate (2.61%), theobromine (2.48%), 1-

Tetradecene (2.38%), n-Nonadecanol-1 (2.32%), 2,2-Dimethoxybutane (2.31%), N-Methoxy-Nmethylacetamide (2.23%), Sucrose (2.13%) and n-Propyl acetate (2.01%). Also the predominant chemical constituents found in inflorescence are as 2,2-dimethoxybutane (3.70%), Tetradecyl trifluoroacetate (3.53%), hexanal (2.75%), 1,2,4-Benzenetricarboxylic acid, 1,2-dimethyl ester (2.70%), hexatriacontane (2.57%) 1-Tetradecene (2.48%), 1,4-Benzenediol, 2,5-bis(1,1-dimethylethyl)- (2.26%) and 9-Tricosene (Z)- (2.08%). Similary the leading chemical compounds were obtained in leaf are as 2,2-dimethoxybutane (5.35%), campesterol (5.14%), n-tridecyl ester (3.31%), 1-Tetradecene (2.83%), Dodecane (2.45%),Trifluoroacetic acid, 1,3,5-Cycloheptatriene, 6-methyl-1-(-6-methyl-1,3,5-cycloheptatrien-1-yl-)- (2.41%) and Nonadecanol-1 (2.24%).

Finally some high percentage chemical compounds were identified in stem included; Sucrose (16.94%), 3-Deoxy-d-mannoic lactone (4.94%), 3-Deoxy-d-mannoic acid (4.07%), Propanal, 2,3-dihydroxy- (3.78%), Glycerin (3.33%), Stegmasterol (2.78%), 1-Tridecene (2.36%), Cholesterol (2.42%). In the earlier study, it has been reported that the identified compounds exert significant biological activity for example Gamma-Sitosterol has antioxidant, antibacterial and prophylactic activities (Venkata, R, *et al*., 2012). Eicosane has a good activity against fungal, bacterial, tumor and cytotoxic effects (Hsouna, A.B, *et al*., 2011). Hexadecanoic acid, methyl ester displaying antifungal, antioxidant, hypocholesterolemic nematicide, pesticide, anti-androgenic flavour, haemolytic, 5-Alpha reductase inhibitor, potent antimicrobial activity (Hema *et al*., 2011). Dibutyl phthalate is used as antifungal, antimicrobial agent and antimalarial (Elija, *et al*., 2012). Dodecane enhances antifungal activity (Cheila, *et al*., 2012). Thymine could be used a target for actions of 5-fluorouracil (5-FU) in cancer treatment (Hofreiter, *et al*., 2001). Lupeol has a complex pharmacology, displaying antiprotozal, antimicrobial, anti-inflammatory, antitumor and chemoprevention properties (Margareth and Miranda, 2009). Theobromine is used as a vasodilator (a blood vessel widener), a diuretic and heart stimulant (William, 1943).

**Table 1: GC-MS identified components of the *Glossostemon bruguieri* flower extract.**

| No. | R.Time | M. Wt | Molecular formula | Flower% | Name and Class of Compound |
|---|---|---|---|---|---|
| | | | | | ***Hydrocarbon Compounds*** |
| **1** | 3.45 | 106 | C8H10 | 0.73 | Benzene, 1,3-dimethyl- |
| **2** | 4.67 | 156 | C11H24 | 1.19 | Undecane |
| **3** | 4.99 | 182 | C13H26 | 1.68 | 1-Tridecene |
| **4** | 6.34 | 210 | C16H18 | 1.10 | 1,1'-Biphenyl, 2,2',5,5'-tetramethyl- |
| **5** | 5.56 | 196 | C14H28 | 2.38 | 1-Tetradecene |
| **6** | 7.45 | 282 | C20H42 | 0.46 | Eicosane |
| **7** | 4.22 | 170 | C12H26 | 1.39 | Octane, 3,4,5,6-tetramethyl- |
| **8** | 8.38 | 506 | C36H74 | 4.19 | Hexatriacontane |
| **9** | 8.79 | 478 | C34H70 | 0.70 | Tetratriacontane |
| **10** | 10.14 | 410 | C30H50 | 0.91 | 2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl-, |
| | | | | | ***Nitrogen Copmounds*** |
| **11** | 2.58 | 103 | C4H9NO2 | 2.23 | N-Methoxy-N-methylacetamide |
| **12** | 4.81 | 102 | C4H10N2O | 0.39 | 2-Propanamine, N-methyl-N-nitroso- |
| **13** | 4.94 | 115 | C5H9NO2 | 0.46 | 5-Methoxypyrrolidin-2-one |
| **14** | 6.75 | 194 | C8H10N4O2 | 0.65 | Caffeine |
| **15** | 6.79 | 180 | C7H8N4O2 | 2.48 | Theobromine |
| | | | | | ***Ester Compounds*** |
| **16** | 2.80 | 102 | C5H10O2 | 2.01 | n-Propyl acetate |
| **17** | 2.91 | 118 | C5H10O3 | 0.54 | 1,2-Propanediol, 2-acetate |
| **18** | 6.04 | 310 | C16H29F3O2 | 2.61 | Tetradecyl trifluoroacetate |
| **19** | 6.87 | 652 | C38H68O8 | 2.80 | l-(+)-Ascorbic acid 2,6-dihexadecanoate |
| **20** | 6.94 | 254 | C1630O2 | 1.23 | 13-Tetradecen-1-ol acetate |
| | | | | | ***Acid Compounds*** |
| **21** | 2.71 | 128 | C6H8O3 | 1.40 | 2-Propenoic acid, oxiranylmethyl ester |
| **22** | 5.52 | 216 | C12H24O3 | 0.57 | Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2- |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | hydroxy-1-methylethyl)propyl ester |
| **23** | 5.95 | 258 | C14H26O4 | 0.30 | Hexanedioic acid, mono(2-ethylhexyl)ester |
| **24** | 6.09 | 286 | C16H30O4 | 0.98 | Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester |
| **25** | 6.71 | 278 | C16H22O4 | 0.74 | 1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester |
| **26** | 7.22 | 322 | C21H38O2 | 0.97 | 10,13-Eicosadienoic acid, methyl ester |
| **27** | 8.66 | 278 | C16H22O4 | 1.50 | 1,2-Benzenedicarboxylic acid, mono(2-ethylhexyl) ester |
| | | | | | ***Alcohol Compounds*** |
| **28** | 3.62 | 100 | C6H12O | 16.96 | Cyclohexanol |
| **29** | 4.38 | 130 | C8H18O | 0.30 | 2-Propyl-1-pentanol |
| **30** | 5.15 | 134 | C5H10O4 | 0.59 | 1,2,3-Propanetriol, 1-acetate |
| **31** | 6.29 | 238 | C9H18O7 | 1.08 | 6-O-Methyl-2,4-methylene-.beta.-sedoheptitol |
| **32** | 6.44 | 414 | C29H50O | 6.76 | gamma.-Sitosterol |
| **33** | 6.49 | 284 | C19H40O | 2.32 | n-Nonadecanol-1 |
| **34** | 7.02 | 238 | C15H26O2 | 0.31 | Cedrane-8,13-diol |
| **35** | 8.25 | 426 | C30H50O | 1.17 | Lupeol |
| | | | | | ***Aldehyde and ketone Compounds*** |
| **36** | 4.87 | 144 | C6H8O4 | 0.59 | 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl- |
| **37** | 6.62 | 268 | C18H36O | 1.47 | 2-Pentadecanone, 6,10,14-trimethyl- |
| **38** | 7.31 | 238 | C16H30O | 2.39 | cis-9-Hexadecenal |
| | | | | | ***Other Compounds*** |
| **39** | 2.52 | 118 | C7H15F | 1.18 | Heptane, 1-fluoro- |
| **40** | 2.66 | 118 | C6H14O2 | 2.31 | 2,2-Dimethoxybutane |
| **41** | 3.53 | 136 | C9H12O | 0.49 | Benzene, (2 methoxyethyl)- |
| **42** | 3.55 | 166 | C10H14O2 | 0.35 | 4-(methoxymethyl)- 2,6-dimethyl-phenol |
| **43** | 4.06 | 106 | C4H10O3 | 0.67 | Tripropylene glycol monomethyl ether |
| **44** | 4.15 | 144 | C6H8O2 | 0.31 | 2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one |
| **45** | 4.17 | 102 | C4H6O3 | 0.49 | 2-Hydroxy-gamma-butyrolactone |
| **46** | 4.59 | 126 | C7H10O2 | 0.44 | Cyclopentane, 1-acetyl-1,2-epoxy- |

| | | | | | |
|---|---|---|---|---|---|
| **47** | 5.19 | 210 | C7H14O7 | 0.94 | Heptose |
| **48** | 5.71 | 342 | C12H22O11 | 2.13 | Sucrose |
| **49** | 7.99 | 324 | C21H40O2 | 0.55 | 4,8,12,16-Tetramethylheptadecan-4-olide |
| **50** | 5.09 | 120 | C8H8O | 0.52 | Benzofuran, 2,3-dihydro- |
| **Total identified compounds** | | | | **80.82%** | |

**Table 2: GC-MS identified components of the *Glossostemon bruguieri* inflorescence extract.**

| No. | R.Time | M. Wt | Molecular formula | Inflorescence% | Name and Class of Compound |
|---|---|---|---|---|---|
| | | | | | ***Hydrocarbon Compounds*** |
| **1** | 5.11 | 168 | C12H24 | 0.52 | Cyclopropane, 1-methyl-2-octyl- |
| **2** | 5.19 | 156 | C11H24 | 1.83 | Undecane |
| **3** | 6.31 | 168 | C12H24 | 1.60 | Cyclopropane, nonyl- |
| **4** | 7.89 | 196 | C14H28 | 2.48 | 1-Tetradecene |
| **5** | 4.60 | 170 | C12H26 | 1.04 | Dodecane |
| **6** | 8.02 | 252 | C18H36 | 1.96 | 9-Octadecene, (E)- |
| **7** | 9.02 | 154 | C11H22 | 0.37 | Cyclodecane, methyl- |
| **8** | 9.41 | 246 | C18H30 | 0.52 | Benzene, (3,3-dimethyldecyl)- |
| **9** | 9.59 | 232 | C17H28 | 0.44 | Benzene, (1-ethylnonyl)- |
| **10** | 9.78 | 232 | C17H28 | 0.37 | Benzene, (1-methyldecyl)- |
| **11** | 9.87 | 210 | C16H18 | 0.65 | 1,1'-Biphenyl, 2,2',5,5'-tetramethyl- |
| **12** | 9.91 | 246 | C18H30 | 0.34 | Benzene, (2,3-dimethyldecyl)- |
| **13** | 9.96 | 238 | C17H34 | 0.53 | Cyclopropane, 1-methyl-1-(2-methylpropyl)-2-nonyl- |
| **14** | 10.05 | 182 | C13H26 | 0.32 | Cyclohexane, 2-butyl-1,1,3-trimethyl- |
| **15** | 10.15 | 322 | C23H46 | 2.08 | 9-Tricosene, (Z)- |
| **16** | 11.14 | 410 | C30H50 | 6.97 | 2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl-, (all-E)- |
| **17** | 12.76 | 478 | C34H70 | 0.37 | Tetratriacontane |
| **18** | 13.23 | 506 | C36H74 | 2.57 | Hexatriacontane |
| | | | | | ***Nitrogen Compounds*** |
| **19** | 9.74 | 281 | C17H15NO3 | 0.69 | Acetamide, N-(acetyloxy)-N-9H-fluoren-2-yl- |
| | | | | | ***Ester Compounds*** |
| **20** | 2.66 | 102 | C5H10O2 | 0.69 | n-Propyl acetate |
| **21** | 9.13 | 310 | C16H29F3O2 | 3.53 | Tetradecyl trifluoroacetate |
| **22** | 10.96 | 278 | C16H22O4 | 0.95 | Dibutyl phthalate |
| | | | | | ***Acid Compounds*** |
| **23** | 7.98 | 216 | C12H24O3 | 0.47 | Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester |
| **24** | 9.23 | 286 | C16H30O4 | 0.59 | Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2- |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | methyl-1,3-propanediyl ester |
| **25** | 10.55 | 278 | C16H22O4 | 0.29 | 1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester |
| **26** | 10.75 | 270 | C17H34O2 | 1.41 | Hexadecanoic acid, methyl ester |
| **27** | 10.89 | 242 | C15H30O2 | 0.85 | Pentadecanoic acid |
| **28** | 11.50 | 322 | C21H38O2 | 1.59 | cis-11,14-Eicosadienoic acid, methyl ester |
| **29** | 11.59 | 298 | C19H38O2 | 0.87 | Heptadecanoic acid, 10-methyl-, methyl ester |
| **30** | 14.50 | 238 | C11H10O6 | 2.70 | 1,2,4-Benzenetricarboxylic acid, 1,2-dimethyl ester |
| | | | | | ***Alcohol Compounds*** |
| **31** | 4.12 | 100 | C6H12O | 15.04 | Cyclohexanol |
| **32** | 11.05 | 284 | C19H40O | 0.76 | n-Nonadecanol-1 |
| **33** | 11.44 | 355 | C24H50O | 0.29 | n-Tetracosanol-1 |
| **34** | 11.65 | 268 | C18H36O | 1.28 | Oleyl Alcohol |
| **35** | 14.55 | 222 | C14H22O2 | 2.26 | 1,4-Benzenediol, 2,5-bis(1,1-dimethylethyl)- |
| **36** | 15.04 | 222 | C14H22O2 | 0.65 | 4,6-di-tert-Butylresorcinol |
| | | | | | ***Aldehyde and ketone Compounds*** |
| **37** | 2.52 | 100 | C6H12O | 2.75 | Hexanal |
| **38** | 10.38 | 226 | C15H30O | 0.61 | Pentadecanal- |
| | | | | | ***Other Compounds*** |
| **39** | 2.78 | 118 | C6H12O2 | 3.70 | 2,2-Dimethoxybutane |
| **40** | 3.88 | 204 | C12H25Cl | 1.45 | Dodecane, 1-chloro- |
| **41** | 8.22 | 342 | C12H22O11 | 0.51 | Sucrose |
| **42** | 11.87 | 914 | C54H108Br2 | 1.93 | Tetrapentacontane, 1,54-dibromo- |
| **43** | 12.65 | 350 | C15H24F6O2 | 0.27 | 1,3-Dioxolane, 4-ethyl-5-octyl-2,2-bis(trifluoromethyl)-, cis- |
| **Total identified compounds** | | | | **71.09%** | |

**Table 3**: GC-MS identified components of the *Glossostemon bruguieri* leaf extract.

| No. | R.Time | M. Wt | Molecular formula | Leaf % | Name and Class of Compound |
|---|---|---|---|---|---|
| | | | | | ***Hydrocarbon Compounds*** |
| **1** | 3.46 | 106 | C8H10 | 1.16 | Benzene, 1,3-dimethyl- |
| **2** | 3.14 | 140 | C10H20 | 0.46 | 1-Decene |
| **3** | 3.23 | 156 | C11H24 | 0.62 | Undecane |
| **4** | 4.20 | 170 | C12H26 | 2.45 | Dodecane |
| **5** | 4.76 | 182 | C13H26 | 1.91 | 1-Tridecene |

| | | | | | |
|---|---|---|---|---|---|
| **6** | 5.57 | 196 | C14H28 | 2.83 | 1-Tetradecene |
| **7** | 6.00 | 182 | C13H26 | 0.50 | Cyclohexane, 2-butyl-1,1,3-trimethyl- |
| **8** | 6.37 | 210 | C16H18 | 2.41 | 1,3,5-Cycloheptatriene, 6-methyl-1-(6-methyl-1,3,5-cycloheptatrien-1-yl)- |
| **9** | 6.43 | 210 | C16H18 | 1.50 | 1,1'-Biphenyl, 2,2',5,5'-tetramethyl- |
| **10** | 6.48 | 252 | C18H36 | 1.07 | 8-Heptadecene, 8-methyl-, (E)- |
| | | | | | ***Nitrogen Compounds*** |
| **11** | 4.45 | 254 | C16H18N2O | 0.20 | Pyrido[2,3-g]indole, 5-methoxy-2,3,7,9-tetramethyl- |
| **12** | 8.38 | 355 | C21H25NO4 | 0.84 | 1H-Indole-2-carboxylic acid, 6-(4-ethoxyphenyl)-3-methyl-4-oxo-4,5,6,7-tetrahydro-, isopropyl ester |
| **13** | 10.35 | 402 | C23H34N2O4 | 0.28 | 5,5'-Di(ethoxycarbonyl)-3,3'-dimethyl-4,4'-dipropyl-2,2'-dipyrrylmethane |
| | | | | | ***Ester Compounds*** |
| **14** | 6.97 | 278 | C16H22O4 | 1.74 | Dibutyl phthalate |
| **15** | 6.99 | 254 | C16H30O2 | 1.72 | 13-Tetradecen-1-ol acetate |
| **16** | 7.49 | 430 | C22H39F5O2 | 1.75 | Nonadecyl pentafluoropropionate |
| | | | | | ***Acid Compounds*** |
| **17** | 5.46 | 200 | C12H24O2 | 0.27 | Propanoic acid, nonyl ester |
| **18** | 6.06 | 296 | C15H27F3O2 | 3.31 | Trifluoroacetic acid,n-tridecyl ester |
| **19** | 6.11 | 286 | C16H30O4 | 1.52 | Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester |
| **20** | 6.75 | 374 | C23H34O4 | 0.98 | Phthalic acid, isobutyl undec-2-en-1-yl ester |
| **21** | 6.83 | 270 | C17H34O2 | 1.72 | Hexadecanoic acid, methyl ester |
| **22** | 6.91 | 404 | C21H41BrO2 | 0.17 | 6-Bromohexanoic acid, pentadecyl ester |
| **23** | 6.79 | 316 | C15H16N4O4 | 0.30 | Pentadioic acid, dihydrazide, N2,N2'-bis(2-furfurylideno)- |
| **24** | 7.80 | 296 | C19H36O2 | 0.46 | trans-13-Octadecenoic acid, methyl ester |
| **25** | 8.73 | 390 | C24H38O4 | 0.23 | 1,2-Benzenedicarboxylic acid, diisooctyl ester |
| | | | | | ***Alcohol Compounds*** |
| **26** | 3.58 | 130 | C8H18O | 0.24 | 1-Hexanol, 2-ethyl- |
| **27** | 3.63 | 100 | C6H12O | 16.72 | Cyclohexanol |
| **28** | 5.69 | 151 | C4H9NO5 | 0.42 | 1,3-Propanediol, 2-(hydroxymethyl)-2-nitro- |
| **29** | 6.52 | 284 | C19H40O | 2.24 | n-Nonadecanol-1 |
| **30** | 8.61 | 386 | C27H46O | 2.84 | Cholesterol |
| **31** | 9.25 | 398 | C28H46O | 0.44 | Dihydrotachysterol |
| **32** | 10.21 | 400 | C28H48O | 5.14 | Campesterol |
| | | | | | ***Aldehyde and ketone Compounds*** |
| **33** | 4.57 | 182 | C10H11ClO | 0.24 | gamma.-Chlorobutyrophenone |

| | | | | | |
|---|---|---|---|---|---|
| **34** | 5.73 | 162 | C10H10O2 | 0.51 | Ethanone, 1,1'-(1,3-phenylene)bis- |
| **35** | 7.26 | 238 | C16H30O | 1.87 | cis-9-Hexadecenal |
| | | | | | ***Other Compounds*** |
| **36** | 2.52 | 118 | C7H15F | 1.95 | Heptane, 1-fluoro- |
| **37** | 2.59 | 92 | C3H8O3 | 1.75 | Glycerin |
| **38** | 2.66 | 118 | C6H14O2 | 5.35 | 2,2-Dimethoxybutane |
| **39** | 4.32 | 144 | C8H16O2 | 1.98 | Cyclohexane, 1,1-dimethoxy- |
| **Total identified compounds** | | | | **72.14%** | |

**Table 4: GC-MS identified components of the *Glossostemon bruguieri* stem extract.**

| No. | R. Time | M. Wt | Molecular formula | Stem % | Name and Class of Compound |
|---|---|---|---|---|---|
| | | | | | ***Hydrocarbon Compounds*** |
| **1** | 4.22 | 156 | C11H24 | 0.64 | Octane, 2,3,3-trimethyl- |
| **2** | 5.00 | 182 | C13H26 | 2.36 | 1-Tridecene |
| **3** | 4.68 | 156 | C11H24 | 0.83 | Undecane |
| **4** | 5.57 | 196 | C14H28 | 1.45 | 1-Tetradecene |
| **5** | 5.63 | 144 | C11H12 | 0.18 | (1-Methylenebut-2-enyl)benzene |
| **6** | 6.37 | 210 | C16H18 | 0.68 | 1,1'-Biphenyl, 2,2',5,5'-tetramethyl- |
| **7** | 6.48 | 252 | C18H36 | 0.81 | Cyclopropane, 1-(1,2-dimethylpropyl)-1-methyl-2-nonyl- |
| **8** | 10.21 | 410 | C30H50 | 0.27 | 2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl-, (all-E)- |
| | | | | | ***Nitrogen Compounds*** |
| **9** | 2.76 | 147 | C9H9NO | 0.65 | 3-(4-Hydroxyphenyl) propionitrile |
| **10** | 3.22 | 116 | C5H12N2O | 0.28 | O-Butylisourea |
| **11** | 3.45 | 149 | C9H11NO | 0.44 | Acetamide, N-(phenylmethyl)- |
| **12** | 4.59 | 126 | C5H6N2O2 | 0.65 | Thymine |
| **13** | 4.82 | 102 | C4H10N2O | 0.12 | 2-Propanamine, N-methyl-N-nitroso- |
| **14** | 7.76 | 387 | C24H37NO3 | 0.65 | 3.beta.-Acetoxy-bisnor-5-cholenamide |
| **15** | 8.05 | 337 | C22H43NO | 0.10 | 13-Docosenamide, (Z)- |
| | | | | | ***Ester Compounds*** |
| **16** | 6.06 | 310 | C16H29F3O2 | 1.03 | Tetradecyl trifluoroacetate |
| **17** | 6.97 | 278 | C16H22O4 | 0.91 | Dibutyl phthalate |
| | | | | | ***Acid Compounds*** |
| **18** | 2.92 | 102 | C4H6O3 | 0.59 | Propanoic acid, 2-oxo-, methyl ester |

| | | | | | |
|---|---|---|---|---|---|
| **19** | 5.30 | 190 | C8H14O5 | 1.56 | Propanoic acid, 3-(acetyloxy)-2-(hydroxymethyl)-, ethyl ester, (+)- |
| **20** | 5.46 | 158 | C8H14O3 | 0.69 | Butanoic acid, 3-oxo-, 2-methylpropyl ester |
| **21** | 5.53 | 216 | C12H24O3 | 0.41 | Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester |
| **22** | 6.02 | 316 | C13H23Cl3O2 | 0.44 | Trichloroacetic acid, undecyl ester |
| **23** | 6.19 | 180 | C6H12O6 | 4.07 | 3-Deoxy-d-mannonic acid |
| **24** | 6.75 | 278 | C16H22O4 | 0.92 | 1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester |
| **25** | 6.83 | 270 | C17H34O2 | 0.46 | Hexadecanoic acid, methyl ester |
| **26** | 6.91 | 652 | C38H68O2 | 0.93 | l-(+)-Ascorbic acid 2,6-dihexadecanoate |
| **27** | 7.36 | 280 | C18H32O2 | 0.44 | 9,12-Octadecadienoic acid (Z,Z)- |
| **28** | 7.41 | 312 | C20H40O2 | 0.12 | Eicosanoic acid |
| **29** | 8.73 | 278 | C16H22O4 | 0.26 | 1,2-Benzenedicarboxylic acid, mono(2-ethylhexyl) ester |
| | | | | | ***Alcohol Compounds*** |
| **30** | 3.41 | 98 | C5H6O2 | 0.18 | 2-Furanmethanol |
| **31** | 3.63 | 100 | C6H12O | 14.87 | Cyclohexanol |
| **32** | 6.53 | 284 | C19H40O | 1.32 | n-Nonadecanol-1 |
| **33** | 8.27 | 386 | C26H46O | 2.42 | Cholesterol |
| **34** | 9.81 | 400 | C28H48O | 1.31 | Ergost-5-en-3-ol, (3.beta.)- |
| **35** | 10.29 | 412 | C29H48O | 2.78 | Stigmasterol |
| **36** | 3.81 | 202 | C11H22O3 | 0.31 | 1-Butanol, 3-methyl-, carbonate (2:1) |
| **37** | 4.39 | 130 | C8H18O | 0.12 | 1-Hexanol, 2-ethyl- |
| **38** | 5.16 | 134 | C5H10O4 | 1.17 | 1,2,3-Propanetriol, 1-acetate |
| **39** | 5.21 | 134 | C5H10O4 | 0.53 | 1,2,3-Propanetriol, monoacetate |
| | | | | | ***Aldehyde and ketone Compounds*** |
| **40** | 3.85 | 98 | C5H6O2 | 0.26 | 1,2-Cyclopentanedione |
| **41** | 4.15 | 144 | C6H8O4 | 0.20 | 2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one |
| **42** | 4.18 | 102 | C4H6O3 | 0.30 | 2-Hydroxy-gamma-butyrolactone |
| **43** | 4.88 | 144 | C6H8O4 | 1.46 | 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl- |
| **44** | 4.94 | 90 | C3H6O3 | 3.78 | Propanal, 2,3-dihydroxy- |
| **45** | 5.12 | 126 | C6H6O3 | 1.75 | 2-Furancarboxaldehyde, 5-(hydroxymethyl)- |
| **46** | 6.12 | 162 | C6H10O5 | 4.94 | 3-Deoxy-d-mannoic lactone |
| | | | | | ***Other Compounds*** |
| **47** | 3.56 | 330 | C18H18O6 | 0.84 | 4,4'-Bis(methoxymethoxy) benzil |
| **48** | 6.44 | 198 | C12H22O2 | 1.14 | 2,2'-Bioxepane |

| | | | | | |
|---|---|---|---|---|---|
| **49** | 7.16 | 354 | C24H50O | 0.41 | Dodecane, 1,1'-oxybis- |
| **50** | 5.78 | 342 | C12H22O11 | 16.94 | Sucrose |
| **51** | 6.31 | 488 | C35H52O | 1.91 | 17-(1,5-Dimethylhexyl)-10,13-dimethyl-3-styrylhexadecahydrocyclopenta[a]phenanthren-2-one |
| **52** | 2.52 | 118 | C7H15F | 0.87 | Heptane, 1-fluoro- |
| **53** | 2.59 | 92 | C3H8O3 | 3.33 | Glycerin |
| **54** | 2.66 | 146 | C8H18O2 | 1.58 | Propane, 2,2'-[ethylidenebis(oxy)]bis- |
| **55** | 2.72 | 86 | C4H6O2 | 1.16 | 2,2'-Bioxirane |
| **Total identified compounds** | | | | **84.76%** | |

## Conclusion

To the best our information this is the first research of comparative anatomical and phytochemical investigation different parts of *G. bruguieri* plant, the chemical compositions from the investigated Moghat Plant were rich in different class of organic compounds like hydrocarbons, nitrogens, esters, acids, alcohols, aldehydes, ketones and others , supported by the anatomical study of stem ,inflorescence , leaf and leaf petioles which showed present of Schizogenous secretory ducts of mucilaginous materials. However, further studies are needed for the isolation of individual compounds from the plant extracts of *G. bruguieri* while in *vitro* and *vivo* studies are needed in order to use a natural source for handling different kind of disease such as anti-inflammatory, antimicrobial antioxidant as well as antitumor agent and aphrodisiac uses of different parts of the plant in addition to root.

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