International Journal Dental and Medical Sciences Research
Volume 4, Issue 5, Sep-Oct 2022 pp 144-152 www.ijdmsrjournal.com ISSN: 2582-6018

Bio-Taxonomic Study Based on Selected Aromatic Plants Species Related to Different Plant Families as Raw Material

Dr. Lina Hassaballa[1*] and Dr. Asaad Alsiddig[2*]
1-Department of Biology, Faculty of Education, University of Khartoum.
2-Department of Biology, Faculty of Education, University of Khartoum.

Submitted: 07-09-2022 Accepted: 17-09-2022

ABSTRACT:
This work is an attempt to make a taxonomic study on some aromatic plants in Tehama area, Al-Baha region Saudi Arabia. It includes a brief description on climate, topography and geology of the study area. The total number of species identified were (4) species depending on their differences in vegetative, floral and fruit characteristics. Scientific classification of each species is provided. Botanical description with notes on habitats and distribution were determined for all of the four species. Medicinal properties and local uses for some species were included. All identified species have been illustrated by photos in their habitats. Botanical names, synonyms were updated and vernacular names (Local names) have been presented. The study revealed that all species have a great ecological, economic and medicinal importance and require more comprehensive studies to conserve them.The study aims to:
1- Determine the distribution and habits of the species of Aromatic plants.
2- Provide medicinal properties and local uses of Aromatic plants and species.
The method was recorded due to Dr. Jacob Thomas, Herbarium Dept., College of Science, King Saud University. The four selected aromatic plant species resulted essential oils, antioxidant activities and volatile oils. Technical methods such as Gas Chromatography (GC) were used to identify the components.
The authors recommend accurate techniques such as DNA fingerprinting to identify these species as they are considered to be a native heritage for their country.
Keywords: Aromatic plants, Lamiaceae (Labiates), Asteraceae, Pandanaceae.

I. INTRODUCTION:

Aromatic plants are botanical raw materials that are primarily used as ornamental plants. They produce and exude aromatic substances (Largely ether oils) which are used for making perfumes, culinary purposes and aromatic components of cosmetics. They also known as herbal drugs for therapeutic andproducing medicinal products.Most of the aromatic plants are species belong to the families: Lauraceae, Umbelliferae, Myrtaceae, Asteraceae, Labiatae... etc.

The outcome of this work was(4) species adequately identified using vegetative, floral and fruit characteristics. The plant materials were collected by the authors throughout different trips (spring – summer). This study will contribute positively to regional flora studies and it is equally hoped that future studies may follow, complete and achieve what the authors could not be achieved previously.

Study area:
Site and Location:
AL- Baha region located in the South West of Saudi-Arabia between Mekka and Aseer.It lies between longitudes (41/42 E) and latitude (19/20 N); it has of (15,000 Sq. Km.) and population of (533,001). **Maps. (1).**

Map (1). Saudi Arabia with Al-Baha highlighted

The capital of the province is AL- Baha city. The other big cities in the area are: Baljourashi, AL-Mikhwah, Sabt ALalaya, EL- Mendaq, Rahwat - ALbar and Gilwa.**Maps (1)** shows the site and Location of the study area.

International Journal Dental and Medical Sciences Research
Volume 4, Issue 5, Sep-Oct 2022 pp 144-152 www.ijdmsrjournal.com ISSN: 2582-6018

Geology and Topography:

Geographically, AL- Baha region is divided by huge rockysteeps into three distinct parts. Sarat which contain the high mountains characterized by temperate and rich plant due to relatively high annual rainfall. Tihama which is low land coastal area located on the west of Sarat and characterized by a very hot and humid weather and very little rain fall average. The third part is the eastern hills characterized by an altitude of (1,550) to (2,450) meters above the sea level with cool winter, hot summer and sparse plant covered. **Map (2).**

Map. (2). Al-Baha location and its surrounding.

Climate:

The climate in the region is greatly affected by its variation in geographical features. Al- Sarat area is exposed to the formation of clouds and fog and this often happens in winter because of air masses coming from the Red Sea**Map (2)** accompanied by thunderstorms.In spring and summer the climate is mild and pleasant. The climate in the Tihama area is different from that in AL- Sarat although they are separated by no more than (25) km. Tihama is an undulating coastal plain, hot in summer, warm in spring and mild in winter .The climate in general, falls in the arid zone, relative humidity varies between (52% and 67%) with maximum temperature of (23Cº) and minimum temperature of (12Cº) The rain falls in range between(229-581 mm.). The average throughout the whole region is (100 – 250 mm.) annually. In AL- Baha city the capital, the climate is mild with temperature between (12 – 23 Cº) due to its location at (2500 m.) above the sea level. Thus, the climate is moderate in summer and cold in winter.

The area shows a great diversity in natural vegetation due to its climate variation and topography. It witness more than (53) forests including Raghdan forest which covered an area of (600,000 Sq.m.) just (5) km. from Al- Baha city, Amdan forest is (55) km. to the north of Al-Bahawhich contains olive trees, Arar shrubs and other natural vegetation, Wadi Feig forest (8)km. from Al- Baha it is encircled by green valley littered with apricot, pomegranate and grape orchards. Wadi AL- Ageeg forest (40) km. from AL- Baha it includes various fruit trees and tall Lotus trees**.**

The selected plant species of this study were: Ocimum basilicum, Organum vulgare, Artemisia absinthium and Pandanus tectorius, commonly, belonged to three plant families Lamiaceae (Labiatae), Asteraceae and Padanaceae.

Brief description:

Family Lamiaceae or Labiates:

Itcontains about (236) generaand (6,900) to (7,200) species commonly named mint family.The plants are frequently aromatic in all parts and include many widely used culinary herbs such as basil, mint, rosemary, sage, savory, marjoram, oregano, hyssop, thyme, lavender, and perilla, some are shrubs or trees such as teak others are rarely vines. Many members of the family are widely cultivated, owing not only to their aromatic qualities but also the ability of cultivation.These plants are among the easiest plants to propagate by stem cuttings besides those grown for their edible leaves; some are grown for decorative foliage such as coleus.

Labiatae characteristically, have stems that are square in cross section and simple leaves in opposite decussate pairs. Flowers hermaphrodite grouped in spikes have five sepals, five petals which are usually fused into a tube that terminates in two distinct lips. Fruit is a carcerulus. Ocimum basilicum**Fig. (1)**and Organum vulgare**Fig. (3)**are examples for this family.

Family Asteraceae (Compositae):

The largest family of flowering plants, comprising about (1,100) genera and (20,000) species. The family has a worldwide distribution and it is the most common in the arid and semi-arid regions of subtropical**.**Plantsare mostly herbaceous, but some are shrubs or trees and climbers.Stems are generally, erect, but can be prostrate to ascending.

International Journal Dental and Medical Sciences Research
Volume 4, Issue 5, Sep-Oct 2022 pp 144-152 www.ijdmsrjournal.com ISSN: 2582-6018

Some species have underground stems in the form of caudices or rhizomes. Leaves simple, but are often deeply lobed or otherwise, incised, often conduplicate or revolute, margins can be entire or lobed or toothed, alternate, opposite or whorled. Inflorescence representsthe most evident characteristic of Asteraceae because of specialized capitulum which superficially look like a single flower, comprises of two types of flowers lacking calyx, ray florets have (3-5) petals fused at the base to form a corolla tube and they may be either actinomorphic or zygomorphic. Disc florets are usually actinomorphic, with (5) petalsin corolla tube. Stamens (5) united; epipetalous. Fruits are achene-like and are called a cypsela (plural cypselae). Although there are two fused carpels, there is only one locule and only one seed per fruit on basal placenta. Artemisia absinthium**Fig. (4)**represents this family.

Family Pandanaceae:

It comprises over (1000) species in five genera of which the genus Pandanus is the most important. It is an ancient family dating from the early to mid-Cretaceous.

It includes trees, shrubs, lianas, vines, epiphytes and perennial herbs. Stems may be simple or branched and may have aerial prop roots. The stems bear prominent leaf scars. The leaves are very long and narrow, sheathing, simple, undivided, with parallel veins; the leaf margins and the midribs are often prickly. The plants are dioecious. The inflorescences are terminally borne racemes, spikes or umbels, with subtended spathes, which may be brightly colored. The flowers are minute and lack of perianths. Male flowers contain numerous stamens with free or fused filaments. Female flowers have a superior ovary, usually of many carpels in a ring but may be reduced to a row of carpels or a single carpel. Fruits are
berries or drupes, usually multiple. Pandanaceae includes five genera: Benstonea, Freycinetia, Martellidendron, Pandanus and Sararanga. Martellidendron is formerly considered subgenera of Pandanus, but were recognized as distinct genera based on DNA sequencing.

The number of tree species in Saudi Arabia is only (97) which represented about (4.32%) of the total floristic elements. Out of these, more than (80%) are presented in the southwestern and western regions including Taif region. [1].

Basil Ocimum basilicum L. **Fig. (1)**is aromatic herbs that are used extensively to add a distinctive aroma and flavor to food. The leaves can be used fresh or dried for use as a spice. Essential oils extracted from fresh leaves and flowers**Graph (1)** can be used as aroma additives in food, pharmaceuticals and cosmetics**.**

Traditionally, basil has been used as a medicinal plant in the treatment of headaches, coughs, diarrhea, constipation, warts, worms, and kidney malfunction.

The antioxidant activities of basil and thyme have been investigated using various model systems and assays. The antioxidant activity**Graph. (1)**of ethanol extract of basil (O. basilicum L.) was investigated by electrochemical measurements.

Major aroma compounds found in volatile extracts of basil exhibited varying amounts of anti-oxidative activity particularly, eugenol, thymol, carvacrol and 4-allylphenol, found in basil and thyme, exhibited potent antioxidant activity comparable to the known antioxidants, (BHT) and a-tocopherol. Considering the abundance of these aroma chemicals in natural plants, the total activity may be comparable or more than those of known antioxidants. Furthermore, ingestion of these aroma compounds may help to prevent in vivo oxidative damage, such as lipid peroxidation, which is associated with cancer, premature aging, atherosclerosis, and diabetes.

II. MATERIALS AND METHODS:

Equipment and Tools:

- Basket, plastic bags, knife and pair of scissors were used for collecting plant materials.
- A note book and a pencil were used to record the information on habits, habitats, distribution, color of fruits and flowers.
- Camera is used to photograph plant samples in their habitats.
- A plant press made of alternating pieces of equal size of cartons, newspapers, a rope were used to press and dry plant specimens.

Plant Materials:

Plant samples were collected by the authors from different places in the study area through several trips, three trips per week had been done throughout the study area in summer and spring seasons. Thirty five plant samples were collected but twenty were identified and only four species were recorded in this study.The plant samples were taken to the laboratory Bio No. (2)in the faculty of the science and artin EL- Mikhwa, then the samples were examined using needles and hand lens.

International Journal Dental and Medical Sciences Research
Volume 4, Issue 5, Sep-Oct 2022 pp 144-152 www.ijdmsrjournal.com ISSN: 2582-6018

Plant Samples Identification:

The identified species were well dried and mounted in album with a card of identification for each includes the date of collection, place, habit, habitats, scientific name, vernacular name and the collector (The name of the authors who collected the species) and left in the lab (Bio No.2) as a tiny herbarium. The following students' generation may use it.

III. RESULTS AND DISCUSSION:

Results:

1- **Ocimum basilicum L.**

Commonly, known as basil, it is an aromatic, annual herb and economic crop, possibly native to India and has been cultivated there for more than (5000) years, it is the best known as a culinary herb prominently featured in Italian cuisine and also plays a major role in Southeast Asian cuisinesof Indonesia, Thailand, Malaysia, Vietnam, Cambodia, Laos and Taiwan. The scientific classification is as follows:

Kingdom: Plantae – Plants
Subkingdom: Tracheobionta – Vascular plants
Super division: Spermatophyta – Seed plants
Division: Magnoliophyta – Flowering plants
Class: Magnoliopsida – Dicotyledons
Subclass: Asteridae
Order: Lamiales
Family: Lamiaceae – Mint family
Genus: Ocimum L.
Species: Ocimum basilicum L.

Synonym: Ocimum americanum.
Vernacular name: Raihan
Habitat: Cultivated, Anthropogenic (Man-made or disturbed habitats), meadows and fields.
Botanical description:

Dicot, herbs. Stem is obtusely quadrangular, flowers are white and purple in color, in whorls in the axils of the leaves, the calyx with the upper lobe rounded and spreading. The leaves, greyish-green beneath and dotted with dark oil cells, opposite, (1) inch long and (1/3) inch broad, stalked and peculiarly smooth, soft and cool to the touch and if slightly bruised exaled a delightful scent of cloves.**Fig. (1).**

Chemical properties:

Based on one laboratory study, Ocimum basilicum L. contains linalol (54.95%), methylchavikol (11.98%), methylcinnamat (7.24%), and linolen (0.14%)[2]. Essential oil**Graph. (1)**is also found in sweet basil along with rosmarinic acid, citral, eugenol, and geraniol.**[3]**.

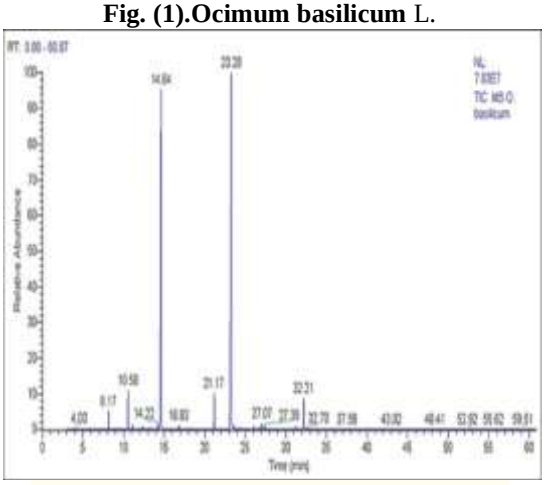
Medicinal properties:

Ocimum basilicum L.shows antibacterial[4], antimicrobial, antiviral and antioxidant activities.

Local uses:

Basil is one of the best loved culinary herbs for good reason, like other herbs in the mint family basil settles the stomach, improves appetite and is a natural disinfectant. Basil is known for its many varieties with distinct aromas that come from different qualities in their essential oils**Graph (1)** contained in the leaves. It used as ornamental plant.

Fig. (1).Ocimum basilicum L.



Graph. (1). Gas chromatography-total ion current of the essential oil of Ocimum basilicum[5].

2- Origanum vulgareL.

Is a common species of Origanum genus of the mint family Lamiaceae. It is native to warm-temperate western and southwestern Eurasia and Mediterranean region. The scientific classification is as follows:

Kingdom: Plantae
Division: Eudicot

International Journal Dental and Medical Sciences Research
Volume 4, Issue 5, Sep-Oct 2022 pp 144-152 www.ijdmsrjournal.com ISSN: 2582-6018

Class: Asterids
Order: Lamiales
Family: Lamiaceae
Genus: Origanum L.
Species: Origanum vulgare L.
Synonym: Origanum creticum L. ;Origanum angelicum Hill. And Origanum compactum Benth.
Vernacular name: Wazab
Habitat: Grassland or open scrub, often in rocky areas and on calcareous soils.

Botanical description:

Dicot, perennial herbs, with creeping roots, sending up woody stems about a foot high, branched above, often purplish. Leaves are ovate (egg-shaped with wider end at the base), (10-40) mm. long and (5-25) mm. wide and borne opposite each other on the stem. The edges of the leaves are smooth or very shallowly toothed and the leaf tips vary from acute (pointed) to obtuse (rounded). Inflorescence is many-flowered with flowers grouped into short dense lateral or terminal spikes. The corolla (ring of united petals) is white to purplish,(4-8) mm.long and has two lips. The calyx (ring of united sepals) is five-toothed. Each flower has four stamens (male parts).Fruit has four small nutlets (single-seeded units).**Fig. (2).**

Fig. (2).Origanum vulgareL.

Chemical components:

The essential oils of oregano are composed primarily of mono-terpenoids and monoterpenes with the relative concentration of each compound varying widely across geographic origin and other factors. Over (60) different compounds have been identified**[6]**.

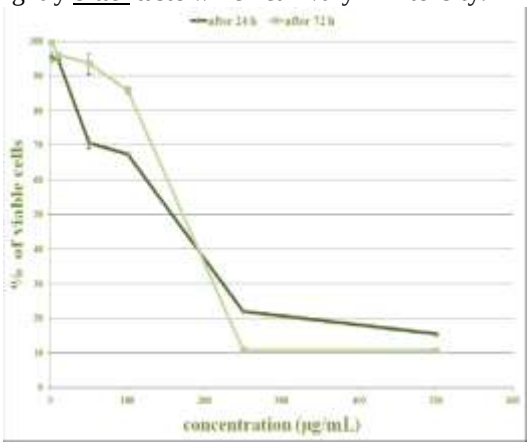
Drying of the plant material affects both quantity and distribution of volatile compounds with methods using higher heat and longer drying times having greater negative impact. A sample of fresh whole plant material found to contain (33g/kg.) dry weight (3.1g/kg wet) decreased to below a third after warm air convection drying. Much higher concentrations of volatile compounds are achieved towards the end of the growing season **[7]**.

Medicinal properties:

There are a number of medicinal uses of oregano (Origanum vulgare) that may surprise you. A powerful anti-bacterial and anti-fungal agent, oregano also has anti-inflammatory, antioxidant and anti-parasitic properties**Graph. (2).** It's typically taken as a supplement or used as an essential oil.

Local uses:

Oregano is an important culinary herb used for the flavor of its leaves, which can be more flavorful when dried than fresh. It has an aromatic warm and slightly bitter taste which can vary in intensity.



Graph. (2). The cytotoxic effect of methanolic extract of O. vulgare on HCT-116 cells, 24 and 72 h after exposure. The effect was measured by MTT cell viability assay. The data are mean ± SD of three independent experiments.[8].

3- Artemisia absinthium

The scientific classification is as follows:

Kingdom: Plantae – Plants
Subkingdom: Tracheobionta – Vascular plants
Superdivision: Spermatophyta – Seed plants
Division: Magnoliophyta – Flowering plants
Class: Magnoliopsida – Dicotyledons
Subclass: Asteridae
Order: Asterales
Family: Asteraceae – Aster family
Genus: Artemisia L.

Synonym:

- Absinthium officinale Lam.
- Absinthium officinale Brot.
- Absinthium vulgare (L.) Lam.
- Artemisia absinthia St.-Lag.
- Artemisia arborescens var.cupaniana Chiov.

International Journal Dental and Medical Sciences Research
Volume 4, Issue 5, Sep-Oct 2022 pp 144-152 www.ijdmsrjournal.com ISSN: 2582-6018

- Artemisia arborescens f. rehan(Chiov.) Chiov.
- Artemisia baldaccii Degen
- Artemisia doonense Royle
- Artemisia inodora Mill.
- Artemisia kulbadica Boiss. & Buhse
- Artemisia pendula Salisb.
- Artemisia rehan Chiov.
- Artemisia rhaetica Brügger

Vernacular name: Berk. Beaitharan

Habitat:

It prefers to grow in full sunlight but grows well with (30-50%) shade.

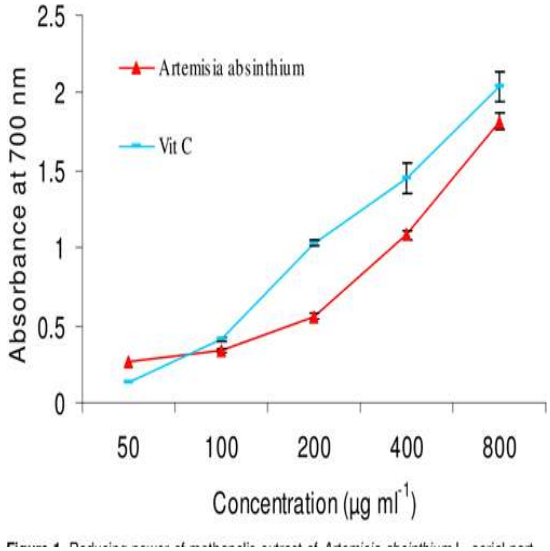
Botanical description:

Monocot, trees that grows to (4–14 m.) (13–46 ft.) tall. The single trunk is spiny and forks at a height of (4–8) meters = (13–26 ft.). It was supported by prop roots that firmly anchor the tree to the ground. Its leaves**Fig. (3)**are usually (90–150) cm. = (3.0–4.9 ft.) long and (5–7 cm.) = (2.0–2.8 inch.) wide with saw-like margins.Flowers dioecious, with very different male and female flowers. Male flowers are small, fragrant; form clusters or racemes and short lived, lasting only a single day. Female flowers resemblepineapples. Fruitsare either ovoid, ellipsoid, subglobose or globose with a diameter of (4–20) cm. = (1.6–7.9 inch) and a length of (8–30) cm. = (3.1–11.8 inch). The fruit is made up of (38–200) wedge-like phalanges which have an outer fibrous husk. Phalanges contain two seeds on average, with a maximum of eight reported. The phalanges are buoyant and the seeds within them can remain viable for many months while being transportedby ocean currents.**Fig. (3).**

Fig. (3).Artemisia absinthium

Medicinal properties:

Can be used for a variety of medicinal purposes. It is perhaps most helpful in treating digestive ailments, including nausea, indigestion and gas as well as for getting rid of parasitic intestinal worms. Problems with the liver and gall bladder have been known to respond well to treatment with Artemisia absinthium. Used externally, it can help muscle pain and heal skin lesions, insect bites and bruises. Other uses include fever reduction, reducing pain for women during labor and easing the symptoms of depression.**Graph. (3).**



Graph. (3). Reducing power of methanolic extracts of Artemisia absinthium L. aerial parts of flowering stage. [9].

4- Pandanus tectorius

Scientific classification is as follows:

Kingdom: Plantae – Plants

Subkingdom: Tracheobionta – Vascular plants

Superdivision: Spermatophyta – Seed plants

Division: Magnoliophyta – Flowering plants

Class: Liliopsida – Monocotyledons

Subclass: Arecidae

Order: Pandanales

Family: Pandanaceae

Genus: Pandanus L. f.

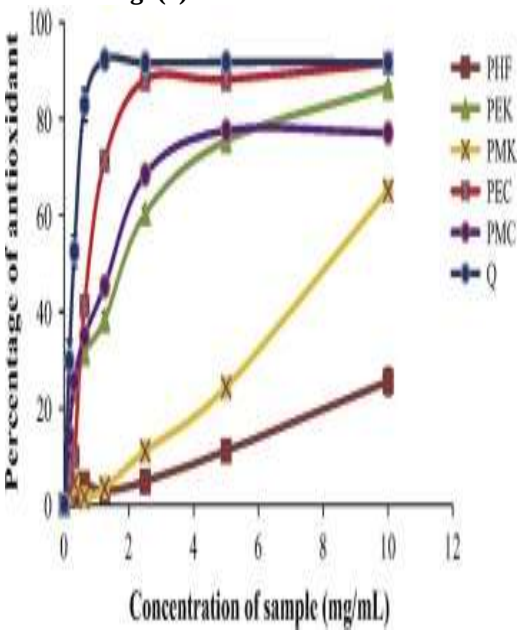
International Journal Dental and Medical Sciences Research
Volume 4, Issue 5, Sep-Oct 2022 pp 144-152 www.ijdmsrjournal.com ISSN: 2582-6018

Synonym: -
Pandanus bageaMiq.,Pandanus baptistii hort. ex Misonne,
Pandanus pedunculatusR.Br.,Pandanus pyriformis (Martelli) H.St.John, Pandanus robinsonii Merr.andPandanus spurius (Willd.) Miq.
Vernacular name: Kady
Habitat:P. tectorius occurs naturally in tropical and subtropical coastal areas, especially on sandy rocky beaches and raised coral terraces.

Botanical description:

Monocot.Small tree to (14 m.) tall, (18 m.) on more fertile sites and with about the same canopy spread (except in taller plants). Plants of most varieties are stout, many branching and have numerous aerial and prop roots and thick, often spiny trunks, though trees with (4-8) m. clear bole are known. Trunk diameter may reach (12–25) cm. or more only in exceptional circumstances. Bark is greyish or reddish brown, smooth or flaky, with characteristic undulating leaf scars and rows of prickles, though differences between the sea or windward side and the leeward face are noted. P. tectorius is dioecious. Male plants are usually more branched, with up to about (30) branches maximum (60) than females which have up to about (15) branches maximum (30). Flowers are borne in heads at the shoot apex. Female flowers resemble pineapples, while male flowers are fragrant, tiny, white, pendant and arranged in racemes or branched in clusters with large white showy bracts and only last for about a day**Fig. (4).** There is considerable variation in leaf shape and size, both on and among trees but often being spirally arranged in three rows and clustered at branch apices. Leaves are dark green(1-3) m. long and (11-16) cm. wide, linear with a gradually attenuating apex, M-shaped in cross section, with short spiny or prickly (2.5) mm. long midribs and margins, although a few varieties have leaves with smooth margins. In fully expanded leaves, the midrib is bent and the upper third of the leaf hangs down giving plants their characteristic drooping appearance. The fruit head varies considerably in morphology and may be ovoid, ellipsoid, subglobose or globose, (8-30) cm. long and (4-20) cm. in diameter comprised of (40-200) tightly bunched, wedge-shaped fleshy, phalanges or drupes, narrowly oblong to ovoid,(3-11)cm. long and (2-6) cm. wide. The redbrown seeds are obovoid, ellipsoid or oblong, (6-20) mm. long adapted from **[10]**.

Fig. (4).Pandanus tectorius



Graph. (4). Antioxidant activity of Pandanustectorius extracts.[11].

Discussion

The study revealed that all of the four identified species are wide spread in the study area that agrees with the study of [12]throughout the area.

Taxonomically, there are many varieties of Ocimum basilicum**Fig. (1),** as well as several related species**Fig. (2),(3)** and **(4)** or species hybrids also called basil. The type used in Italian food is typically called sweet basil as opposed to Thai basil (O. basilicum var. thyrsiflora), lemon basil (O. X citriodorum) and holy basil (Ocimum tenuiflorum) which are used in Asia. While most common varieties of basil are treated as annuals, some are perennial in warm tropical climates

including holy basil and a cultivar known asAfrican Blue.The importance of all species is very obvious not only ecological wise but also as medicinal plants and haseconomic benefits**[13]**.

Insecticidal effects: Culex pipiens is usually, the most common pest mosquito in urban and suburban settings. Sweet basil has been studied for its repellent effects on Culex pipiens**[14].**

IV. CONCLUSION AND RECOMMENDATION:

From the above results and discussion we can conclude that, the aromatic plant species are widely spread in the study area. The four identified species in current study are just an example. Each of the identified species has a great value in somehow.Depending on the wide range of habitat, the identified species are vital for various ecosystems and play a key role in maintaining the region's environmental balance and stability. It also helps in the protection of watersheds, stabilization of slopes, improvement of soils and moderation of climate.

Conservation of biological diversity and the sustainable use of the resources of the earth are enshrined in Islamic law and principles. Successful conservation of biodiversity requires involvement of all stakeholders from the smallest local communities to the global community. Therefore, the authors recommend the following:

1- More studies are required to identify the entire flora of the region.
2- Comprehensive taxonomic studies using new techniques in the fields of Ecology, Histology, Cytogenetic, Biochemistry and Molecular Biology should be conducted for identification.
3- Immediate intervention is badly needed to protect not only Aromatic plant spp. but also, the entire flora of the area to attain sustainability.
4- Comprehensive biochemical studies are badly needed to make use of the chemical components of the identified species.

REFERENCES:

[1]. Chaudhary, S.A. (2001). Flora of the Kingdom of Saudi Arabia 3: 1-368. Ministry of Agriculture & Water, Riyadh.doi: 10.4103/0257-7941.144618

[2]. Mahmoudi, M., Ebrahimzadeh, M. A., Ansaroudi,F., Nabavi, S.F. and Nabavi, S.M. (2009). Antidepressant and antioxidantactivities of Artemisia Absinthium L. at flowering stage – 8(24): 7170 – 7175.ISSN 1684–5315 © 2009 Academic Journals

[3]. Opalchenova, G. and Obreshkova, D.(2003). Comparative studies on the activity of basil--an essential oil from Ocimum basilicum L.--against multidrug resistant clinical isolates of the genera Staphylococcus, Enterococcus and Pseudomonas by using different test methods - 54(1):105-110. doi: 10.1016/s0167-7012(03)00012-5

[4]. Thomson LAJ, Englberger L, Guarino L, Thaman RR, Elevitch C, (2006). Pandanus tectorius (screw pine). Species profiles for Pacific island agroforestry. Holualoa, Hawaii, USA: Permanent Agriculture Resources (PAR), 29 pp. www.traditionaltree.org

[5]. Jacob Thomas, Herbarium Dept., College of Science, King Saud University. http://www.ksu.edu.sa/sites/Colleges/CollegeofScinces/BotanyDepartment/habg/Default.aspx

[6]. Rady, M. R. and Nazif, N. M. (2005). Rosmarinic acid content and RAPD analysis of in vitro regenerated basil (Ocimum americanum) plants - 76(6):525-533. DOI:10.1583/nsb649464

[7]. Figiel, Adam; Szumny, Antoni; Gutiérrez-Ortíz, Antonio; Carbonell-Barrachina, Ángel A. (2010). "Composition of oregano essential oil (Origanum vulgare) as affected by drying method - 98 (2): 240–
7. DOI:10.1016/j.jfoodeng.2010.01.002

[8]. Filip Grbović, Milan S. Stanković *, Milena Ćurčić, Nataša Đorđević, Dragana ŠeklićMarina Topuzović and Snežana Marković. (2013). The cytotoxic effect of methanolic extract of O. vulgare - 2(3): 372 – 378. https://doi.org/10.1080/13102818.2019.1577701

[9]. Joshi ,R.K.(2014).Chemical composition and antimicrobial activity of the essential oil of Ocimum basilicum L. (sweet basil) from Western Ghats of North West Karnataka, India - 33(3): 151–156. **doi: 10.4103/0257-7941.144618**

[10]. Teixeira, Bárbara; Marques, António; Ramos, Cristina; Serrano, Carmo; Matos, Olívia; Neng, Nuno R; Nogueira, José M F; Saraiva, Jorge Alexandre; Nunes, Maria Leonor (2013). "Chemical composition and bioactivity of different oregano (Origanum vulgare) extracts and essential oil - 93 (11): 14.2707. doi: 10.1002/jsfa.6089

[11]. Wannissorn, B., Jarikasem, S., Siriwangchai, T., and Thubthimthed, S.(2005). Antibacterial properties of essential oils from Thai medicinal plants. Fitoterapia ;76(2):233-236. DOI: 10.1016/j.fitote.2004.12.009

[12]. Gushash, Ahmed Saeed Mohamed (2006). Plants in the Mountains of Sarat and Hejaz. Medina- Sarawat Designers & Printers: 2208, 1427. https://doi.org/10.1016/j.arabjc.2015.11.003

[13]. Erler, F., Ulug, I., and Yalcinkaya, B. (2006). Repellent activity of five essential oils against Culex pipiens - 77(7-8):491-494. DOI: 10.1016/j.fitote.2006.05.028

[14]. Yosie Andriani and Habsah Mohamad. (2019). Phytochemical analysis, antioxidant, antibacterial and cytotoxicity properties of keys and cores part of Pandanustectorius fruits – 12(8): 3555 – 3564. https://doi.org/10.1016/j.arabjc.2015.11.003