IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

PHYTOCHEMICAL POTENTIAL OF GENUS *PLECTRANTHUS* AND *OCIMUM*: A REVIEW

Dhruvi J.Patel[1], Mohitgiri A.Goswami[1], Hiteshkumar A. Solanki[1]

[1]Department of Botany, Bioinformatics & Climate Change Impacts Management, Gujarat University, Ahmedabad-380009, Gujarat, India.

ABSTRACT

Phytochemicals are non-nutritive plant chemicals that have protective or disease preventive properties. It is well-known that plants produce these chemicals to protect them but recent researches demonstrate that they can also protect humans against diseases. Lamiaceae is a family comprising 236 genera and more than 7000 species. It is one of the most widely used and phytochemically studied families, because of their various compounds. Lamiaceae can be divided into two major categories, the first one includes all those species that mainly produce volatile terpenoids, found in the volatile compounds, such as *Salvia* sp., *Ocimum* sp., *Plectranthus* sp., *Mentha* sp., *Thymus* sp., and Rosmarinus sp. On the other hand, Terpenes phenolic acids (rosmarinic, caffeic acids) and Alkaloids (apigenin, hesperidin), are also detected. Genus *Ocimum* is widespread over Asia, Africa, and Central, Southern America, and India. As plants known for medical value, the plants of the genus *Ocimum*. It heals many diseases chronically due to its chemical constituent and it believes that it has anti-aging and, Immunomodulatory properties along with antimicrobial and anticancer properties. *Ocimum* is a huge genus within the family Lamiaceae, comprising about 64 species of annual to perennial aromatic medicinal herbs with a long history of traditional uses. *Plectranthus* (Lamiaceae) is widely distributed in the world and has a range of popular therapeutic indications. This work aimed to evaluate the phytochemical characterization of two leaf extracts of Plectranthus and their antimicrobial, antineoplastic, and immunomodulatory potential. Plectranthus is a potential candidate for therapeutic use due to its low toxicity in healthy human cells and exhibits biological activities of medical interest as bacteriostatic, fungistatic and immunomodulatory. *Plectranthus* is one of the most representative genera of the Lamiaceae family. Therefore, the purpose of this review is to produce a comprehensive review by summarizing the results from the literature on phytochemical constituents of the Lamiaceae family with main emphasis on genus *Plectranthus* and *Ocimum*.

Keywords: Lamiaceae, *Ocimum*, *Plectranthus*, Phytochemical study.

1. INTRODUCTION:

An antioxidant or free-radical scavenger is a molecule that inhibits the oxidation of other molecules. The process by which a molecule, atom, or ion loses electrons during a reaction is known as oxidation. When an atom's or molecule's oxidation status increases, oxidation takes place. Oxidation reactions can produce free radicals. In turn, these radicals can start chain reactions. The sources of natural antioxidants are mainly plants, i.e., eatable vegetables, fruits, spices, and herbs, which are rich in vitamins, phenolic compounds, carotenoids, and microelements. When a chain reaction occurs in a cell, it can cause injury or death to the cell. In eliminating free radical intermediates and preventing further oxidation events, antioxidants put an end to these chain reactions. Antioxidants, which are reducing agents like thiols, ascorbic acid (vitamin C), or polyphenols, accomplish this by becoming oxidized themselves (Mattson and Cheng, 2006). Natural antioxidants play a key role in health maintenance and prevention of chronic and deteriorating diseases such as cancer, coronary heart disease, and even altitude sickness (Manach *et al*., 2009; Uddin *et al*., 2008; Jayasri *et a*l., 2009). Antioxidants also have many industrial uses, such as preservatives in food and cosmetics and to prevent the degradation of rubber and gasoline (Ayodele *et al*., 2015).

Terpenoids, alkaloids, tannins, carbohydrates, terpenoids, steroids, and flavonoids are some of the chemical compounds found in medicinal plants that have a specific physiological effect on humans (Edoga *et al.*, 2005). Basic metabolism, or rather secondary metabolism, of living things produces these chemicals. Secondary metabolites are very diversified chemical and taxonomically substances with unknown biological roles. It are extensively employed in numerous fields, including scientific research, veterinary medicine, agriculture, and human therapy (Vasu *et al*., 2009). In-vitro studies on a wide range of microbes have demonstrated the inhibitory effects of several phytochemicals from various chemical classes (Cowan, 1999; Yadav *et al.*, 2011).

As there is currently no evidence linking phytochemicals to any potential negative impacts on human health, they are not considered essential nutrients. They are recognised to play a part in safeguarding human health. Almost four thousand phytochemicals have been categorised based on their chemical properties, physical attributes, and protective role. These categories typically apply to phytochemicals: carotenoids, polyphenols (which include phenolic acids, stilbenes, and lignans), and lignans. flavonoids are further divided as flavones, anthocyanins, isoflavones, and flavanols (Balamurugan *et al.*, 2019).

The primary and secondary chemicals are known as phytochemicals. Primary material include proteins, chlorophyll, and common sugars; secondary elements include terpenoid, alkaloids, and phenolic chemicals (Krishnaiah *et al*., 2007). Terpenoids show a variety of significant pharmacological properties, including anti-inflammatory, anti-cancer, anti-malarial, inhibition of cholesterol formation, and anti-viral and anti-bacterial properties (Mahapo *et al.*, 1997). In addition to attracting beneficial mites, terpenoids also eat herbivorous insects (Kappers *et al.*, 2005). Medicinal plants consist of alkaloids, which are utilised as anaesthetic agents (Hérouart *et al.*, 1998; Wadood *et al.*, 2013).

Antioxidants are essential for the body's protection against free radical damage. They accomplish this by inhibiting the creation of new free radical species, transforming existing ones towards free radicals, producing less harmful compounds that are readily cleaned up, and halting radical chain reactions(Lukhoba et al.,2006). Antioxidants primarily prevent oxidative damage to the human body by preventing free radicals from initiating or extending oxidising chain reactions, which suspends the oxidation of other molecules (Adel-Mogib *et al.*, 2002). Natural plant compounds called phytochemicals can be found in a variety of foods, including fruits, vegetables, grains, legumes, and plant leaves. They contribute to a plant's defence mechanism by giving it colour, flavour, and odour (Pham *et al.*, 2019). Eating a variety of plant-based foods high in phytochemicals may help prevent at least 25% of cancer instances and other significant illnesses including heart disease and stroke. According to recent studies, these compounds are created by plants as a

means of self-defence, but they can also shield humans from sickness (Nguyen *et al.*, 2019; Tran *et al.*, 2019). Around 6000 phytochemicals have been identified and identified in natural goods, which come from a variety of sources like fruits, vegetables, spices, drinks, and other foods (Lukhoba *et al.*, 2006; Adel-Mogib *et al.*, 2002). The age-old practice of treating human illness with extracts from medicinal plants has seen a sharp upsurge in recent years. Degenerative diseases like cancer are brought on by free radicals. Over the past 50 years, the number of people affected by cancer has increased, making it one of the most common and upsetting diseases. Recently, the phenolic chemicals that are derived from plants have drawn a lot of public attention. The impacts of phenolic ingredients on nutrition and health interactions within the human body are true. Owing to their high level of antioxidant activity, antioxidants can lower oxidative stress (Nguyen *et al.*, 2020).

1.1 LAMIACEAE FAMILY:

Having about 4000 species and 220 genera worldwide, the Labiatae family (Lamiaceae) is one of the biggest and most unique groups of flowering plants. Different members of this family have yielded a large number of chemically active essential oils. Nearly 80 species and 22 genera of the plant family—some of which are endemic are found in Yemen (Hedge, 1992; Wood, 1997). The chemistry and biology of the essential oils derived from Yemeni Lamiaceous aromatic plants have not received much attention (Ali *et al.*, 20011).

The genus Lamiales includes the family Lamiaceae, once known as Labiatae. At 236 genera and more than 7000 species, it is the sixth biggest family of angiosperms. It is separated into 12 sub-families, 16 tribes, and 9 sub-tribes (Frezza *et al.*, 2019). Lamiaceae are widely used in medicinal and cosmetic uses (Aguiar *et al.*, 2014). Several famous genera are members of this family, include sage (*Saliva*), mint (*Mentha*), and basil (*Ocimum*) (Waldia *et al.*, 2011; Ahmed *et al.*, 2023).

Medicinal plants are widely used in traditional medicine, and their usage continue to inspire the creation of new pharmacological substances. Numerous of these therapeutic plants contain anti-inflammatory, hepatoprotective, neuroprotective, antioxidant, and radical-scavenging qualities (Perry *et al.*, 1999; Lin and Huang, 2000). Therefore, a lot of focus has been placed on the use of antioxidants in clinical medicine in the past few years, primarily for intervention as well as therapies of various human diseases. Medicinal plants that are aromatic and fragrant and are widely used to treat a variety of human ailments are found in the Lamiaceae family, which is one of the most significant. *Ocimum* (Lamiaceae) species, such as *O. sanctum, O. basilicum, O. kilimandscharicum,* and *O. gratissimum* are found in large quantities in tribal regions of Baipariguda, Koraput (Dt), Odisha. The tribal people have long used these species extensively for a variety of medical conditions, including headaches, digestive issues, inflammation, cardiovascular illness, malaria, and common colds. The plant is known as *Ocimum basilicum* Linn., or sweet basil in English, is an aromatic herb that grows to a height of 60 to 90 cm. It has hairy stems and green branching. Its opposite green leaves are ovate, simple, glabrous, entire, base cuneate, and strongly scented. Its flowers are white or pale purple in simple or heavily branched racemes, and the fruits are ellipsoid, black, and pitted nutlets. *Ocimum basilicum* has been used as a diuretic, antibacterial, sedative, preservative, and digestive regulator in traditional medicine. It has also been suggested for the treatment of headaches, coughs, upper respiratory tract infections, renal malfunction, and toxin elimination (Gupta *et al.*, 2002; Harborne, 1973; Sen, 1993; Nahak *et al.*, 2011).

Having cosmopolitan distribution in India, *Ocimum sanctum* Linn., or holy basil, is an upright plant growing to a height of 30 to 75 cms. Leaves: elliptic, oblong, obtuse, 2.5–5 cms in length, 1.6–3.2 cms wide. The flowers are arranged in compact whorls in racemes that are 15-20 cm long, with a verticillate inflorescence. The taste is strong and fragrant. *Ocimum sanctum* Linn. medicinal value in Ayurveda has been well-documented (Gupta *et al.*, 2002; Prakash and Neelu, 2005). In addition, it may have antifertility, anticancer, antidiabetic, antifungal, antibacterial, hepatoprotective, cardioprotective, analgesic, and

adaptogenic properties. A single species of the genus *Ocimum* plant that is native to East Africa is *Ocimum kilimandscharicum*. They was brought to India and some regions of Turkey where it was cultivated. It is an aromatic perennial under shrub that is evergreen and a member of the Lamiaceae family. It may be propagated both vegetatively and by seeds, and it grows naturally as a rounded, woody shrub that reach a height of two metres in mild temperate areas of the tropics. Simple leaves of the plant are opposite, oblong, narrow at the base, and deeply serrated. It bears pubescent quadrangular branchlets (Warrier et al., 1996). The essential component of the plant is found in the aromatic oils found in the leaves of the plant. Indian locations that are both hot and temperate are home to *Ocimum gratissimum* Linn. commonly known as Camphor basil. The plant can reach a height of between one and two feet. The branches and stem are either bright yellow or green in colour. The oval-shaped, sharp, pointed leaves are between 1-2 inches long. The seeds have thick edges, a circular shape at one end that is flattened, and a tiny, black tint. They are also somewhat elongated. It produces a tingling feeling by stimulating nerve endings. Since the leaves have a clove-like flavour, they are frequently used to flavour vegetables and other foods (Gupta *et al.*, 2002; Harborne, 1973; Sen, 1993; Nahak *et al.*, 2011).

There are six Lamiaceae species that have high levels of antioxidant activity: *Lamium album*, *Galeopsis speciosa*, *Stachys officinalis*, *Leonurus cardiaca*, and *Marrubium vulgare*. These species' biological composition, medicinal use, and pharmacological characteristics have all been documented. Dead nettle, or *Lamium album* L., is used to treat kidney, bladder, and menstruation issues. It also possesses antispasmodic, diuretic, and hemostatic qualities. Coughs and stomach issues are treated with *Marrubium vulgare* L., which has terpenoids, iridoids, flavonoids, and diterpenoids. For digestive, astringent, tonic, anthelmintic, and antiseptic reasons, Stachys officinalis Franch. is utilised. Treatments for coughs and stomach issues include *Marrubium vulgare* L., which include terpenoids, iridoids, flavonoids, and diterpenoids. For digestive, astringent, tonic, anthelmintic, and antiseptic reasons, *Stachys officinalis* Franch. is utilised. In its tannins, flavonoids, soluble silica, and saponins, Galeopsis speciosa is used as an expectorant, diuretic, and astringent. Many authors (Mantle *et al.*, 2000; Trouillas *et al.*, 2003; Vander Jagt *et al.*, 2002) have examined the antioxidant activities of these six species; nevertheless, methodological variations across the research make it challenging to compare the findings (Matkowski and Piotrowska, 2006).

Additionally, using three in vitro experiments, the antioxidative properties of methanolic extracts from six wild European Lamiaceae species have been investigated. The species with the highest to lowest antioxidant activity in the DPPH scavenging assay were *Leonurus cardiaca*, *Lamium album*, *Marrubium vulgare*, *Stachys officinalis*, *Lamium purpureum*, and *Galeopsis speciosa*. *S. officinalis* and *M. vulgare* achieved a maximum inhibition of 78% in the LPO assay, whereas *G. speciosa* only reached 65%. *Lamium* sp. and *L. cardiaca* just exceeded 70% (Matkowski and Piotrowska, 2006), phenolic metabolites were present in significant amounts in all of the extracts, ranging from 13.2% GAE in *S. betonica* to 20% in *L. cardiaca*. Numerous writers have shown that *L. cardiaca* possesses a substantial amount of antioxidant capacity (Mantle *et al.*, 2000; Trouillas *et al.*, 2003; Vander Jagt *et al.*, 2002; Krishnaiah *et al.*, 2011).

Table 1. Qualitative analysis of four *ocimum* species (Nahak *et al.*, 2011)

Phytochemicals	*O.sanctum*	*O.basilicum*	*O.kilimandascharicum*	*O.gratisimum*
Alkaloids	1	1	1	1
Cardiac glycoside	0	0	0	0
Anthraquinone	1	1	1	1
Gums mucilage	1	1	1	1
Proteins	1	1	1	1
Amino acids	1	1	1	1
Tanins	1	1	1	1
Phenolic compound	1	1	1	1
Triterpenoids	1	1	1	1
Steroids	1	1	1	1
Sterols	1	1	1	1
Saponins	1	1	1	1
Flavones	1	1	1	1
Flavonoids	1	1	1	1
Thiol group	0	0	0	0

0 = Absent, 1 = Present

1.2 GENUS: PLECTRANTHUS

The family Lamiaceae includes the genus *Plectranthus*. About 300 species make up this genus, which is found all over the globe Over 45 of these species are used ethnobotanically on the African continent (Lukhoba *et al.*, 2006). Numerous ethnomedical applications of *Plectranthus* species exist, including phytotherapy with antibacterial, antiviral, anti-malaria, and antifungal effects (Lukhoba *et al.*, 2006). Among the Plectranthus species, *Plectranthus barbatus* Andrews is thought to be one of the most significant medicinal species. *P. barbatus* is an invasive species that originated in northeastern Africa and is currently present in sub-Saharan Africa (Rice *et al.*, 2011). It has been utilised for centuries in Hindu and Ayurvedic traditional medicine, as well as in folk medicine from Brazil, tropical Africa, and China (Lukhoba *et al.*, 2006; Maioli *et al.*, 2010; Kapewangoloa *et al.*, 2013)

The 3rd largest genus in the Lamiaceae family, *Plectranthus* has a lengthy history in conventional medicine. All around the world, it has been used to treat a variety of illnesses. This genus is rich in secondary metabolites, including quinone, long-chain alkylcatechol, flavonoids, phenolic compounds, diterpenes, monoterpenes, and sesquiterpenes, according to phytochemical investigations. According to numerous studies' reports on the phytochemical and pharmaceutical activities, it has a wide range of biological activities, including analgesics, larvicidal, anticancer, antioxidant, antifungal, anti-inflammatory, antidiabetic, anti-urolithiactic, and antibacterial properties (Ahamed *et al.*, 2023).

In antispasmodic therapy, *P. barbatus* is taken primarily to treat intestinal spasm-related stomach troubles (Almeida, 2003). The plant is supposedly traditionally used as a phytotherapy against malaria in Kenya (Nguta *et al.*, 2010). In vitro pharmacological research has confirmed that *P. barbatus* is a natural therapy against candida, according to reports (Runyoro *et al.*, 2006; Kapewangolo *et al.*, 2013)

Plectranthus is a big, widely distributed genus of plants with a variety of traditional purposes in the Lamiaceae family. There are over 300 species in this genus, which are found in tropical and subtropical regions of Australia, Asia, and Africa (Abdel Khalik, 2016; Amina *et al.*, 2017; Lukhoba *et al.*, 2006). Seven species of *Plectranthus*, which are found across the southern region of the kingdom, are represented in Saudi Arabia (Abdel-Khalik, 2016). Notable medicinal plants of the Plectranthus family are widely used to cure a variety of illnesses. There are several documented traditional medical uses of *P. barbatus* in Africa, China, South America, India (Hindu and Ayurvedic medicine), and other regions. The majority of these plant species are used to treat respiratory and gastrointestinal problems, cardiac conditions, liver exhaustion, malaria, and some ailments of the central nervous system (Alasbahi and Melzig, 2010; Lukhoba *et al.*, 2006;

Viswanathaswamy *et al.,* 2011). Diterpenoids of various types, especially the abietane-type, are abundant in *Plectranthus* species and have been linked to a range of pharmacological activities, including antifungal and antibacterial (Abdissa *et al.,* 2017; Gaspar-Marques *et al.,* 2006;), cytotoxic (Amina *et al.,* 2017), and antiplasmodial (Alegre-Gómez *et al.,* 2017; Mothana *et al.,* 2014). The current project, which is a component of our ongoing research on the biological activities of Saudi medicinal herbs, intends to supply information on the antioxidant potential, anticancer, and antimicrobial properties of three Plectranthus species: *Plectranthus cylindraceus* Hocst. ex Benth., *Plectranthus asirensis* JRI Wood, and *Plectranthus barbatus* Andrews(Mothana et al.,2018) **.**

Plants of commercial and medical relevance are found in several *Plectranthus* species. In Saudi Arabia, for example, *P. tenuiflorus* is one of several species that are planted as ornamentals. In Swaziland, the tubers of an undetermined *Plectranthus* species are consumed (Ogle *et al.,* 1990; Abdel-Mogib *et al.,* 2002). For their edible tubers, livingstone potato tubers, P. esculentus, are grown in tropical Africa (Purseglove, 1987; Temple *et al.,* 1991). *P. floribundus* is grown in Nigeria and enjoyed in Natal for its edible tubers (Holland, 1995; Perrot *et al.,* 1944; Abdel-Mogib *et al.,* 2002). *P. amboinicus* seed oil is administered topically to the ear in Polynesia to treat acute edematous otitis acuta (Zepernick *et al.,* 1972). In Saudi Arabia, *P. tenuiflorus* leaf extract is also used to treat ear infections (Abulfatih, 1987). Plants of commercial and medical relevance are found in several *Plectranthus* species. Numerous species In Saudi Arabia, *P. asirensis* leaves are used to wounds as an antiseptic dressing (Abulfatih, 1987). In Africa, people chew *P. caninus* leaves to treat toothaches (Kokwaro, 1987). The leaves of P. elegans are employed as a vermicide in East Africa (Kokwaro, 1987).In Indian ayurvedic medicine, *P. vettiverioides* is suggested as a treatment for nausea and vomiting (Dash *et al.,* 1987). *P. barbatus*, an East African medicinal plant, is used as a purgative and as a treatment for stomach aches. Additionally, it is resistant to insect assault, and it has been shown to contain a diterpene that acts as an aphid anti-feedant (Kubo *et al.,* 1984; Mogib *et al.,* 2002)

The essential oils and diterpenoids found in *Plectranthus* species are said to have a variety of pharmacological properties, including antibacterial, antifungal, cytotoxic, and antiplasmodial properties (Amina *et al.,* 2017; Alasbahi and Melzig, 2010; Waldia *et al.,* 2011; Mothana *et al.,* 2018). *Plectranthus cylindraceus* Hocst. ex Benth. (also known as P. montanus Benth.), *Plectranthus asirensis* J.R.I. Wood (also known as Coleus arabicus Benth.), and *Plectranthus barbatus* Andrews are the three species of *Plectranthus* that are grown in Saudi Arabia. Accordingly, the specific goals of this study are to present comprehensive information regarding the chemical makeup, cytotoxic potential, antimicrobial properties, and antioxidant capacities of these three species (Mothana et al., 2018).

There are twelve perennial fragrant plants and shrubs of the genus *Plectranthus* (Lamiaceae) that grow wild in Yemen (Wood, 1997; Miller and Morris, 2004). Skin, intestinal, and respiratory disorders have all been treated with *Plectranthus* species in traditional medicine (Ghazanfar, 1994; Lukhoba *et al.,* 2006). Research on *Plectranthus* species' phytochemical makeup revealed the existence of several chemicals, mostly from the eudesmane sesquiterpenes, labdane, abietane, and ent-kaurane diterpenoids and triterpenoids families (Nyila *et al.,* 2009; Kebede *et al.,* 2011; Waldia *et al.,* 2011). and essential oils that include monoterpene hydrocarbons, oxygenated monoterpenes, and sesquiterpene hydrocarbons as their primary constituents (Agnanie *et al.,* 2011, Mallavarapu *et al.,* 2005; Ali *et al.,* 2012)

1.3 GENUS: OCIMUM

Figure 1. *Ocimum gratissimum*

There are 200 species of herbs and shrubs in the Lamiaceae family's genus *Ocimum* (Simon *et al.*, 1999). Because its leaf gives many items a unique flavour, this species has a long history of use as culinary herbs. It is also a source of essential oils and aroma compounds with nematicidal and insecticidal qualities that are physiologically active (Deshpande and Tipnis, 1997; Chaterje *et al.*, 1982). However, because of their redox characteristics, which allow them to function as reducing agents, hydrogen donators, and singlet oxygen quenchers, phenolic compounds are positively connected with the antioxidative potential of herbs and spices (Caragay, 1992). The primary phenolic compounds present in plants are secondary metabolites with strong antioxidant activity that are widely distributed throughout the Lamiaceae family of plants (Gang *et al.*, 2001; Hakkim *et al.*, 2008)

Tulsi is a fragrant, upright herb with branches that blases hair everywhere. They contain a type of fragrant oil, which is why they are aromatic. There are two types of tulsi: Krishna tulsi has reddish-purple leaves and Shri tulsi has green leaves. Tulsi is employed in Ayurvedic remedies due to its therapeutic properties (Nahak *et al.*, 2011). The common name for *Ocimum gratissimum* is smell leaf. With root, stem, and leaf systems, it is a fully grown blooming plant (Iwu, 1993). Many ailments, including diarrhoea, headaches, fever, ocular conditions, skin problems, and pneumonia, can be naturally treated with the herb (Onajobi, 1986; Ilori *et al.*, 1996; NJOKU *et al.*, 2011).

Three essential oil chemotypes (methyl chavicol, methyl eugenol, methyl cinnamate, and linalool) as well as other subtypes were identified by Lawrence (1993) based on more than 200 studies of oils isolated from *O. basilicum*. The primary chemicals' biosynthetic origins led to their classification as either single- or dual-biosynthetic chemotypes. *O. gratissimum* (Ntezurubanza *et al.*, 1987; Fun and Svendsen, 1990; Jankovsky *et al.*, 1990; Pino and Rosado, 1990) is known to exhibit eugenol-rich and thymol-rich *O. canum* (Ngassoum *et al.*, 2004), and terpinen-4-ol-rich *O. canum* (Sanda *et al.*, 1998). On the other hand, until 2006, not much information had been published about the antioxidant capacity of essential oils derived from the *Ocimum* species (Trevisan *et al.*, 2006). At present, many antimicrobial, immunomodulatory, antistress, anti-inflammatory, anti-ulcer, antidiabetic, hepatoprotective, chemoprotective, antihyperlipidemic, cardioprotective, antioxidant, antitussive, radioprotective, memory-enhancing, antiarthritic, antifertility, antihypertensive, anticoagulant, anticataract, anthelmintic, and antinociceptive properties have been reported for species in the *Ocimum* genus. Because of this, a number of the genus's species, including *Ocimum sanctum, Ocimum gratissimum,* and *Ocimum micranthum,* have been important components of several traditional medicines and are presently being evaluated as possible sources of novel drugs (Uritu *et al.*, 2018).

Table 2 shows the phytochemicals detected in *O. gratissimum* leaf extract. Tests for tannins, steroids, terpenoids, flavonoids and cardiac glycosides were positive in both methanolic and aqueous extracts. Anthraquinones were detected only in the aqueous extract while alkaloids were detected only in the methanolic extract. Saponins were not detected in both extracts (Afolabi *et al*., 2007). The variety of the species' morphology and chemistry is widely documented. Inter- and intraspecific hybridization, polyploidy, aneuploidy, synonymous names, different kinds and cultivars, and an enormous variety of chemotypes are all blamed for this vast heterogeneity (Gupta *et al.*, 2018).

Table 2. Phytochemicals in methanolic and aqueous leaf extract of *O. gratissimum* (Afolabi *et al*.,2007)

Phytochemicals	**Methanolic extracts**	**Aqueous extracts**
Alkaloids	1	0
Saponins	0	1
Tannins	1	1
Phlobatannins	1	1
Anthraquinones	0	1
Steroids	1	1
Terpenoids	1	1
Flavonoids	1	1
Cardiac glycosides:		
i. With steroids	1	1
ii. With deoxy	**0**	**1**

2. SIGNIFICANCE OF PHYTOCHEMICAL ANALYSIS

FUNCTIONS OF PHYTOCHEMICALS IN THE LIVING ORGANISMS

1. Antioxidants, which stop vital macromolecules like proteins, lipids, and nucleic acids from being oxidatively damaged).
2. Antimicrobial agents: those included in Volume 2 that are antiviral, antifungal, antibacterial, and anti-trypanocidal.
3. Immune system stimulation.
4. Alteration of the enzymes that detoxify.
5. Reduction of inflammation.
6. A decrease in platelet clusters.
7.Physiological activities such as interfering with the binding of pathogens to cell receptors.

Plants naturally produce fundamental natural compounds called alkaloids. They are typically found as salt that has organic acids in it. Among plant compounds, they are regarded as the most effective medicinal agent. Because of their analgesic and antibacterial qualities, pure synthetic alkaloids can be employed as pharmaceuticals. (Eleazu *et al.,* 2012) Because it is an acetylated mannose polymer, tannin is utilised in medicine. Heart glycosides are used to treat diabetes and ulcers, and saponin is utilised as a natural cleaner. (Karunyadevi *et al.,* 2009). Plants contain phytochemicals called flavonoids, which have a variety of beneficial properties including antioxidant, antibacterial, and anti-inflammatory properties. Terpenoids are antibacterial and antidiarrheal substances . In the traditional medical system, plants are primarily used to treat a variety of illnesses. Plants often include a wide variety of phytochemicals with specific functions, such as flavonoids, terpenoids, phenolphthalein, saponin, tannin, and alkaloids. (sofowara *et al.*,2014.),

carried out the initial screening procedure for phytoconstituents. The plants that were chosen for phytochemical analysis appeared to have the ability to both enhance the health of the consumers who were tested and serve as a source of effective medications. This research validates the use of various plant species in medicine (Pradeep et al.2014).

Phytochemicals are organic compounds that are naturally present in grains, fruits, and vegetables. In contrast to vitamins and minerals, they are nutritionally worthless. On the other hand, they can affect different bodily functions. Together with other nutrients and dietary fibre, they help the body fend against illness, slow down the ageing process, and lower the risk of a variety of conditions like high blood pressure, cancer, heart disease, and stroke (Igwenyi *et al.*, 2011). The findings showed that in addition to their nutritional worth, the plants under study included a variety of components with significant therapeutic significance. In support of this, several pieces of evidence were also acquired (Pepsi *et al.*, 2012).

Plant compounds with defensive or disease-preventive qualities are known as phytochemicals. They are not food. They are unnecessary nutrients that are mostly generated by plants as a means of defence. Consuming phytochemicals through diet may have a positive impact on health by warding against chronic degenerative conditions including cancer, heart disease, and neurological illnesses. The majority of foods have phytonutrients or phytochemicals, including whole grains, legumes, fruits, vegetables, and herbs. These phytochemicals have great therapeutic potential to treat a wide range of illnesses, either by themselves or in combination. Food-based phytochemicals with nutraceutical qualities are extremely important because they protect against a wide range of illnesses and conditions, including cancer, heart disease, diabetes, high blood pressure, inflammation, microbial, viral, and parasitic infections, psychotic diseases, spasmodic conditions, ulcers, osteoporosis, and related disorders (Prakash *et al.*, 2012).

3. ANTIOXIDANT POTENTIAL :

A vital mechanism for shielding plants from oxidative damage brought on by a variety of environmental conditions, including temperature, light, salt, and nutritional restriction, is the antioxidant response in plants. These main variables cause oxidative stress, which likely damages membranes and modifies the quantity and composition of antioxidant molecules, hence affecting the tissue's overall antioxidant activity. Plants are compelled to build defence mechanisms against ultraviolet (UV) radiation and excessive generation of free radicals through the buildup of antioxidant compounds during high solar radiation periods and extremely cold temperatures. Antioxidants can protect against the cell damage that free radicals cause, known as oxidative stress.

This, in turn, may lead to:

- an excessive release of free iron or copper ions
- an activation of phagocytes, a type of white blood cell with a role in fighting infection
- an increase in enzymes that generate free radicals
- a disruption of electron transport chains

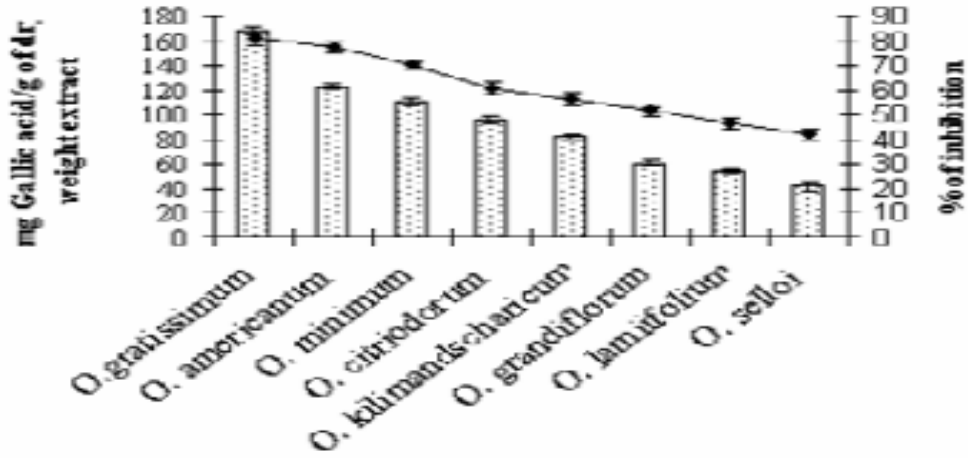

Figure 2. Corelation between DPPH activity and total phenolic content of 8 *Ocimum* sps. leaf extracts (Hakkim *et al.*, 2008).

The damage caused by oxidative stress has been linked to cancer, atherosclerosis , and vision loss. It is thought that the free radicals cause changes in the cells that lead to these and possibly other conditions. An intake of antioxidants is believed to reduce these risks. According to one study: "Antioxidants act as radical scavenger, hydrogen donor, electron donor, peroxide decomposer, singlet oxygen quencher, enzyme inhibitor, synergist, and metal-chelating agents". Other research has indicated that antioxidant supplements may help reduce vision loss due to age-related macular degeneration in older people. Overall, however, there is a lack of evidence from a trusted Source that a higher intake of specific antioxidants can reduce the risk of disease. In most cases, results have tended to show no benefit, or a detrimental effect, or they have been conflicting.

3.1 BENEFITS OF ANTIOXIDANTS:

Antioxidants are helpful in different parts of the biological system as follows:-

- It enhances the immune function
- It helps the oral health
- Decreased risk of kidney stones, reduces obesity
- Mostly epidemiological research and research on tea consumption, concentrated tea extracts may not be safe
- Prevent food containing fat or oil from going rancid due to oxidation, i.e. developing an unpleasant odour or flavour.
- Prevent the oxidation of cut fruits (Miller and Britigan, 1997; Ayodele *et al.*, 2015)

4. CONCLUSIONS:

Phytochemicals are nutritional or non-nutritional bioactive plant compounds found in fruits, vegetables, cereals, and other plant foods. They may have health advantages in addition to basic nutrition, such as lowering the risk of major chronic diseases. Nature is a unique source of structures of high phytochemical diversity, many of them possessing interesting biological activities and medicinal properties. On the basis of review of literature, it concluded that genus *Ocimum* and genus *Plectranthus* are highly rich in phytochemicals properties like antibacterial, antifungal, anti-cancerous, antioxidant, anti-inflammatory, anti-diabetic activities etc. From present compilation, it is observed that researchers need to establish the relationship between structure and function along with clinical studies on the efficacy of plants chemical components. Furthermore, validating the link between the traditional uses and therapeutic effects should be carried out further, and the toxicity of this plant also should be studied systematically. Well- designed and strictly controlled clinical trials are also needed to validate safety and efficacy of dose before its recommendations for human consumption. In conclusion, the future of phytochemical research holds

immense promise. As we explore their therapeutic potential, we aim to unlock safer and more effective treatments for various health conditions.

REFERENCES

1. Abdel-Mogib, M., Albar, H. A., & Batterjee, S. M. (2002). Chemistry of the genus Plectranthus. *Molecules*, *7*(2), 271-301.
2. Abdissa, N., Frese, M., Sewald, N. (2017). Antimicrobial abietane-type diterpenoids from Plectranthus punctatus. *Molecules.*, *22(11),* E1919.
3. Abulafatih, H. A. (1987). Medicinal plants in southwestern Saudi Arabia. *Economic Botany*, *41*(3), 354-360.
4. Adel-Mogib, M., Albar, H . A. & Batterjee , S. (2002). *Molecules.*, *7*, 271–301.
5. Agnaniet, H., Agrebi, A., Bikanga, R., Makani, T., Lebibi, J., Casabianca, H., Morère, A., Menut, C. (2011). Essential oil of Plectranthus tenuicaulis leaves from Gabon, source of (R), (E)-6, 7-epoxyocimene. An unusual chemical composition within the genus Plectranthus. *Natural Product Communications*, *6*, 409-416.
6. Ahamed, A. N., Yaser, S. M., Idhris, S. M., Padusha, M. S. A., & Sherif, N. A. (2023). Phytochemical and pharmacological potential of the genus plectranthus—a review. *South African Journal of Botany*, *154*, 159-189.
7. Alasbahi, R. H., & Melzig, M. F. (2010). Plectranthus barbatus: a review of phytochemistry, ethnobotanical uses and pharmacology–part 1. *Planta medica*, *76*(07), 653-661.
8. Alegre-Gómez, S., Sainz, P., Simões, M. F., Rijo, P., Moiteiro, C., González-Coloma, A., & Martínez-Díaz, R. A. (2017). Antiparasitic activity of diterpenoids against Trypanosoma cruzi. *Planta medica*, *83*(03/04), 306-311.
9. Ali, N. A., Wurster, M., Alkaf, A. G., Fadail, I., Sharaf, I., & Lindequist, U. (2011). Lavandula pubescens Decine-A potential source of carvacrol-rich essential oil in Yemen. *The University of Aden Journal of Natural and Applied Sciences*.
10. Amina , M., Alam, P., Parvez, M. K., Al-Musayeib, N. M., Al-Hwaity, S.A., Al-Rashidi, N. S., Al-Dosari , M. S. (2017). Isolation and validated HPTLC analysis of four cytotoxic compounds, including a new sesquiterpene from aerial parts of Plectranthus cylindraceus. *Nat Prod Res.*, *8*, 1–6.
11. A-Ogle, B., Mitt, Inst., Allg., Bot, Hamburg, (1990). 23b, 895.
12. Ayodele, O. D., Oyegbade, O., & Oseni, S. R. (2015). Phytochemical analysis and antioxidant activities of dry and fresh leaves of Petivera alliacea and Ocimum gratissimum. *International Journal of Sciences: Basic and Applied Research*, *24*(3), 1-13.
13. Balamurugan, V., Fatima, S., & Velurajan, S. (2019). A guide to phytochemical analysis. *International Journal of Advance Research and Innovative Ideas in Education*, *5*(1), 236-245.
14. Câmara, C. C., Nascimento, N. R., Macêdo-Filho, C. L., Almeida, F. B., & Fonteles, M. C. (2003). Antispasmodic effect of the essential oil of Plectranthus barbatus and some major constituents on the guinea-pig ileum. *Planta Medica*, *69*(12), 1080-1085.
15. Caragay, A. B. (1992). Cancer preventive foods and ingredients. *Food Technol.*, *4*, 65-68.
16. Chatterjee, A., Sukul, N. C., Laskar, S., & Ghoshmajumdar, S. (1982). Nematicidal principles from two species of Lamiaceae. *Journal of Nematology*, *14*(1), 118.

17. Cowan, M.M. (1999). Plant products as antimicrobial agents. *Clin. Microbiol. Rev*., 564-582.

18. Dash, V. B., & Kashyap, V. L. (1980). *Materia medica of ayurveda*. Concept Publ. Company.

19. Deshpande, R. S., & Tipnis, H. P. (1997). Insecticidal activity of Ocimum basilicum L.

20. Edoga, H.O., Okwu, D.E., Mbaebie, B.O. (2005). Phytochemicals constituents of some Nigerian medicinal plants. *Afr. J. Biotechnol*., *4(7),* 685-688.

21. Eleazu, C. O., Eleazu, K. C., Awa, E., Chukwum, S. C., (2012). Comparative study of the phytochemical composition of the leaves of five Nigerian medicinal plants. *Journal of Biotechnology and Pharmaceutical Research*, 3(2): 42-46.

22. Frezza, C., Venditti, A., Giuliani, C., Sebastiano, F., 2019. Preliminary study on the phytochemical evolution of different Lamiaceae species based on iridoids. *Biochem. Syst. Ecol., 82,* 44–51.

23. Fun, C. E., Svendsen, A. B., Baerheim-Svendsen, A., (1990). Composition of the essential oils of Ocimum basilicum var. canum and O. gratissimum L. grown on Ariba. *FlaVour Fragrance J. 53,* 173-177.

24. Gang, D. R., Wang, J., Dudareva, N., Nam, K. H., Simon, J. E., Lewinsohn, E., & Pichersky, E. (2001). An investigation of the storage and biosynthesis of phenylpropenes in sweet basil. *Plant physiology*, *125*(2), 539-555.

25. Gaspar-Marques , C., Rijo,P., Simões, M. F., Duarte, M. A., Rodriguez, B. (2006). Abietanes from Plectranthus grandidentatus and P. hereroensis against methicillin- and vancomycin-resistant bacteria. *Phytomedicine., 13,* 267 –71.

26. Ghazanfar, A. S. (1994). Arabian medicinal plants. In *USA: Library of Congress cataloging in the USA*.

27. Gupta, S. K., Prakash, J., & Srivastava, S. (2002). Validation of traditional claim of Tulsi, Ocimum sanctum Linn. as a medicinal plant. *Indian journal of experimental biology*, *40*(7), 765-773.

28. Gupta, S., Srivastava, A., Shasany, A. K., & Gupta, A. K. (2018). Genetics, cytogenetics, and genetic diversity in the genus Ocimum. *The Ocimum Genome*, 73-87.

29. Hakkim, F. L., Arivazhagan, G., & Boopathy, R. (2008). Antioxidant property of selected Ocimum species and their secondary metabolite content. *Journal of Medicinal Plants Research*, *2*(9), 250-257.

30. Harborne, J. B. (1973). Phytochemical methods. London: *Chapman and Hall Ltd*.

31. Hedge, I. C. (1992) . A global survey of the biogeography of the Labiatae. In Advances in Labiatae Science. Harley RM, Reynolds T (Eds). *Royal Botanical Gardens.*, Kew, UK, 7-17.

32. Hérouart, D., Sangwan, R. S., Fliniaux, M. A., & Sangwan-Norreel, B. S. (1988). Variations in the leaf alkaloid content of androgenic diploid plants of Datura innoxia. *Planta medica*, *54*(01), 14-17.

33. Holland, J. H., (1915). The Useful Plants of Nigeria. Bull. Misc. Inform. Kew Addit., Ser. 9, 527.

34. Igwenyi, I. O., Offor, C. E., Ajah, D. A., Nwankwo, O. C., Ukaomah, J. I. and Aja, P. M., (2011). Chemical compositions of Ipomea aquatica (Green Kangkong). *Int. J. Pharma and Bio., 2*(4), B 594-598.

35. Ilori, M. O., Sheteolu, A. O., Omonigbehin, E. A., & Adeneye, A. A. (1996). Antidiarrhoeal activities of Ocimum gratissimum (Lamiaceae). *Journal of Diarrhoeal Diseases Research*, 283-285.

36. Iwu, M. M. (1993). African medicinal plants. *CRC Press, Maryland. Jamkhande, PG, Ajgunde, BR, & Jadge, DR (2017). Annona cherimola Mill.(Custard apple): A review on its plant profile, nutritional values, traditional claims and ethnomedicinal properties. Oriental Pharmacy and Experimental Medicine*, *17*(3), 189-201.

37. Jankovsky, M.; Taborsky, J.; Hubacek, J.; Hlava, B., Volatile substances in basil (Ocimum gratissimum L.). *Sborník ÚVTIZ, Zahradnictví*, *17*(1), 59-68.

38. Jayasri, M. A., Mathew, L., & Radha., A. (2009). A report on the antioxidant activities of leaves and rhizomes of Costus Pictus, D.Don. *International Journal of Integretive Biology*.,*5* , 20-26.

39. Kapewangolo, P., Hussein, A. A., & Meyer, D. (2013). Inhibition of HIV-1 enzymes, antioxidant and anti-inflammatory activities of Plectranthus barbatus. *Journal of ethnopharmacology*, *149*(1), 184-190.

40. Kappers, I. F., Aharoni, A., van Herpen, T.W., Luckerhoff, L.L., Dicke,M., *et al*. (2005). Genetic engineering of terpenoid metabolism attracts bodyguards to Arabidopsis. *Science*., *309*, 2070-2072.

41. Karunyadevi, S., Arun, N., & Surekha, V. (2009). Screening of phytochemical compounds, antioxidant and antimicrobial activity of Aloe vera and Arkaa. *Advanced Biotech*, *9*(6), 38-43.

42. Kebede, W., Bisrat, D., & Asres, K. (2011). Free radical scavenging activity-guided isolation of a diterpenoid from Plectranthus punuctatus. *Natural Product Communications*, *6*(9), 1934578X1100600904.

43. Kokwaro, J. O. (1976). *Medicinal plants of east Africa*. East African Literature Bureau.

44. Krishnaiah , D., Sarbatly, R., Bono, A.(2007). Phytochemical antioxidants for health and medicine: A move towards nature. *Biotechnol Mol Biol Rev*., *1*, 97-104.

45. Krishnaiah, D., Sarbatly, R., Bono, A. (2007) . Phytochemical antioxidants for health and medicine: A move towards nature. *Biotechnol Mol Biol Rev 1*, 97-104.

46. Kubo, I., Matsumoto, T., Tori, M., & Asakawa, Y. (1984). Structure of plectrin, an aphid antifeedant diterpene from Plectranthus barbatus. *Chemistry Letters*, (9), 1513-1516.

47. Lin, C. C., Huang, P. C. (2000). Antioxidant and hepatoprotective effects of Acathopanax senticosus. *Phytother. Res.*, *14*, 489-494.

48. Lukhoba, C. W., Simmonds M. S. J., Paton , A. J. (2006). Plectranthus: a review of ethnobotanical uses. *J Ethnopharmacol.*, *103*, 1–24.

49. Lukhoba, C. W., Simmonds, M. S. J., Paton, A. J., (2006). Plectranthus: a review of ethnobotanical uses. *Journal of Ethnopharmacology 103, 1–24.*

50. Mahato, S. B., Sen, S. (1997). Advances in triterpenoid research.1990-1994. *Phytochemistry.*,*44*, 1185-1236.

51. Maioli, M. A., Alves, L. C., Campanini, A. L., Lima, M. C., Dorta, D. J., Groppo, M., ... & Mingatto, F. E. (2010). Iron chelating-mediated antioxidant activity of Plectranthus barbatus extract on mitochondria. Food Chemistry, 122(1), 203-208.

52. Mallavarapu, G. R., Ramesh, S., Mengi, N., Kalra, A., (2005). Chemical composition of the essential oil of Plectranthus melissoides Benth. *Journal of Essential Oil Research*, 17, 259-260.

53. Manach, C., Hubert, J., Llorach, R., & Scalbert, A. (2009). The complex links between dietary phytochemicals and human health deciphered by metabolomics. *Molecular nutrition & food research*, *53*(10), 1303-1315.

54. Mantle, D., Eddeb, F., & Pickering, A. T. (2000). Comparison of relative antioxidant activities of British medicinal plant species in vitro. *Journal of Ethnopharmacology*, *72*(1-2), 47-51.

55. Matkowski, A., & Piotrowska, M. (2006). Antioxidant and free radical scavenging activities of some medicinal plants from the Lamiaceae. *Fitoterapia*, *77*(5), 346-353.

56. Mattson, M. P., & Cheng, A. (2006). Neurohormetic phytochemicals: low-dose toxins that induce adaptive neuronal stress responses. *Trends in neurosciences*, *29*(11), 632-639.

57. Miller, A. G., & Morris, M. (2004). *Ethnoflora of the Soqotra Archipelago* , 759.

58. Miller, R. A. & Britigan, B. E. (1997). "Role of oxidants in microbial pathophysiology". *Clinical Microbiology Reviews , 10 (1),* 1–18.

59. Mothana, R. A., Al-Said, M. S., Al-Musayeib, N. M., El Gamal, A. A., Al-Massarani, S. M., Al-Rehaily, A. J., ... & Maes, L. (2014). In vitro antiprotozoal activity of abietane diterpenoids isolated from Plectranthus barbatus Andr. *International Journal of Molecular Sciences*, *15*(5), 8360-8371.

60. Mothana, R. A., Khaled, J. M., Noman, O. M., Kumar, A., Alajmi, M. F., Al-Rehaily, A. J., & Kurkcuoglu, M. (2018). Phytochemical analysis and evaluation of the cytotoxic, antimicrobial and antioxidant activities of essential oils from three Plectranthus species grown in Saudi Arabia. *BMC complementary and alternative medicine*, *18*, 1-10.

61. Nahak, G., Mishra, R. C., & Sahu, R. K. (2011). Phytochemical investigation and in vitro antioxidant evaluation of some Ocimum species. *Journal of Pharmacy Research*, *4*(7), 2340-2343.

62. Ngassoum, M. B., Ousmaila, H., Ngamo, L. T., Maponmetsem, P. M., Jirovetz, L., & Buchbauer, G. (2004). Aroma compounds of essential oils of two varieties of the spice plant Ocimum canum Sims from northern Cameroon. *Journal of Food Composition and Analysis*, *17*(2), 197-204.

63. Nguta, J. M., Mbaria, J. M., Gakuya, D. W., Gathumbi, P. K., Kiama, S. G. 2010a. Antimalarial herbal remedies of Msambweni, Kenya. *Journal of Ethnopharmacology 128*, 424–432.

64. Nguye , P. M., Bach, L. G., Mac, H. C., Luu, Y. L., Vo, T. B. T., Tran, V. T. (2019). *J.Pharm. Sci. Resear., 11,* 279-283.

65. Nguyen, P. M., Tran, H. P. T., Nguyen, T. T. T., & Bach, L. G. (2019) *Research on Crops., 20,* 180-186.

66. NJOKU, Obioma, U., JOSHUA, Parker, Elijah; A. G. U., Chidozie, Victor, and D. I. M., Nzubechukwu, C., (2011). Antioxidant Properties of *Ocimum gratissimum* (Scent Leaf). *New York Science Journal;4(5),*98-103]. (ISSN: 1554- 0200)

67. Ntezurubanza, L., Scheffer, J. J. C., Svendsen, A. B., Baerheim, Svendsen, A., (1987). *Composition of the essential oil of Ocimum gratissimum* grown in Rwanda. Planta Med. *53*, 421-423.

68. Nyila, M. A., Leonard, C. M., Hussein, A. A., & Lall, N. (2009). Bioactivities of Plectranthus ecklonii constituents. *Natural Product Communications*, *4*(9), 1934578X0900400903..

69. Onajobi, F. D. (1986). Smooth muscle contracting lipid-soluble principles in chromatographic fractions of Ocimum gratissimum. *Journal of ethnopharmacology*, *18*(1), 3-11.

70. Pepsi, A., Ben, C. P., & Jeeva, S. (2012). Phytochemical analysis of four traditionally important aquatic species. *International Research Journal of Biological Sciences*, *1*(5), 66-69.

71. Perrot, E., (1944). Matières Premières Usuelles du Règne Vègètal Masson Paris, Tome Second, 1089-2343.

72. Perry, E. K., Pickering, A. T., Wang, W. W., Houghton, P. J. (1999). Perru N. S. Medicinal plants and Alzheimer's disease: from ethnobotany to phytotherapy. *J. Pharm. Pharmacol., 51,* 527-534.

73. Pham , T. N., Tran, B. P., Tran ,T. H., Nguyen, D. C., Nguyen, T. N. P., Nguyen, T. Q., Vo, D. V .N., Le, X. T., Nguyen, D. T., Bach, L. G. (2019). IOP Conf. Ser. Mater. *Sci. Eng.*,479 012012.

74. Pino, J. A., Rosado, A., & Fuentes, V. (1996). Composition of the essential oil from the leaves and flowers of Ocimum gratissimum L. grown in Cuba. *Journal of Essential Oil Research*, *8*(2), 139-141.

75. Pradeep, A., Dinesh, M., Govindaraj, A., Vinothkumar, D., & Ramesh Babu, N. G. (2014). Phytochemical analysis of some important medicinal plants. *Int J Biol Pharm Res*, *5*(1), 48-50.

76. Prakash, D., Gupta, C., & Sharma, G. (2012). Importance of phytochemicals in nutraceuticals. *Journal of Chinese Medicine Research and Development*, *1*(3), 70-78

77. Prakash, P. A. G. N., & Gupta, N. (2005). Therapeutic uses of Ocimum sanctum Linn (Tulsi) with a note on eugenol and its pharmacological actions: a short review. *Indian journal of physiology and pharmacology*, *49*(2), 125.

78. Purseglove, J. W. (1987). Tropical Crops: Dicotyledons Longman Group Ltd. *Burnt Hill*.

79. Rice, L. J., Brits, G. J., Potgieter, C. J., & Van Staden, J. (2011). Plectranthus: A plant for the future?. *South African Journal of Botany*, *77*(4), 947-959.

80. Runyoro, D. K., Matee, M. I., Ngassapa, O. D., Joseph, C. C., & Mbwambo, Z. H. (2006). Screening of Tanzanian medicinal plants for anti-Candida activity. *BMC complementary and alternative medicine*, *6*, 1-10.

81. Salles Trevisan, M. T., Vasconcelos Silva, M. G., Pfundstein, B., Spiegelhalder, B., & Owen, R. W. (2006). Characterization of the volatile pattern and antioxidant capacity of essential oils from different species of the genus Ocimum. *Journal of agricultural and food chemistry*, *54*(12), 4378-4382.

82. Sanda, K., Koba, K., Baba, G., Amouzouvi, K. A., Tschala, W., Akpagana, K., ... & Gaset, A. (1998). Ocinum canum sims-a lesser known source of volatile oil with terpineol-4. *Bulletin of the Chemical Society of Ethiopia*, *12*(2), 173-176.

83. Sen, P. (1993). Therapeutic potentials of Tulsi: from experience to facts. *Drugs News & Views*, *1*(2), 15-21.

84. Simon, J. E., Morales, M. R., Phippen, W. B., Vieira, R. F., & Hao, Z. (1999). Basil: A source of aroma compounds and a popular culinary and ornamental herb. *Perspectives on new crops and new uses*, *16*, 499-505.

85. Temple, V. J., Ojobe, T. O., Onobun, C. E. J., (1991). Sci. Food Agr., 56, 215.

86. Tran, Q. T., Le, T . T., Pham, M. Q., Do, T. L., Vu, M. H., Nguyen, D. T., Bach , L. G., Bui, L. M & Pham, Q. L. (2019). *Molecules* ., 24 895.

87. Trouillas, P., Calliste, C. A., Allais, D. P., Simon, A., Marfak, A., Delage, C., & Duroux, J. L. (2003). Antioxidant, anti-inflammatory and antiproliferative properties of sixteen water plant extracts used in the Limousin countryside as herbal teas. *Food chemistry*, *80*(3), 399-407.

88. Uddin, S. N., Akonsi, M.A., Mubassara, S. & Yesmin, M. N (2008).“Antioxidant and Antibacterial activities of Trema Cannabina”. *Middle East Journal of Scientific Research,3*, 105-108.

89. Uritu, C. M., Mihai, C. T., Stanciu, G. D., Dodi, G., Alexa-Stratulat, T., Luca, A., ... & Tamba, B. I. (2018). Medicinal plants of the family Lamiaceae in pain therapy: A review. *Pain Research and Management*, *2018*..

90. VanderJagt, T. J., Ghattas, R., VanderJagt, D. J., Crossey, M., & Glew, R. H. (2002). Comparison of the total antioxidant content of 30 widely used medicinal plants of New Mexico. *Life Sciences*, *70*(9), 1035-1040.

91. Vasu, K., Goud, J.V., Suryam, A., Singara, Chary, M.A. (2009). Biomolecular and phytochemical analyses of three aquatic angiosperms. *Afr. J. Microbiol. Res., 3(8),* 418-421.

92. Viswanathaswamy, A. H., Koti, B .C., Gore , A., Thippeswamy ,A.H., Kulkarni, R.V. (2011). Antihyperglycemic and antihyperlipidemic activity of Plectranthus amboinicus on normal and alloxan-induced diabetic rats. *Indian J Pharm Sci. 73(2),* 139–45.

93. Wadood, A., Ghufran, M., Jamal, S. B., Naeem, M., Khan, A., & Ghaffar, R. (2013). Phytochemical analysis of medicinal plants occurring in local area of Mardan. *Biochem anal biochem*, *2*(4), 1-4.

94. Waldia, S., Joshi, B. C., Pathak, U., & Joshi, M. C. (2011). The genus Plectranthus in India and its chemistry. *Chemistry & biodiversity, 8(2),* 244-252.

95. Waldia, S., Joshi, B. C., Pathak, U., Joshi, M. C., (2011). The genus Plectranthus in India and its chemistry. *Chem. Biodivers., 8,* 244–252.

96. Warrier, P. K. (1993). *Indian medicinal plants: a compendium of 500 species*, Orient Blackswan.

97. Wood , JRI. (1997). A Handbook of the Yemen Flora.RoyalBotanical Gardens, Kew, UK, 236.

98. Wood JRI. (1997) A Handbook of the Yemen Flora.*RoyalBotanical Gardens*, Kew, UK, 236.

99. Yadav, R. N. S., & Agarwala, M. (2011). Phytochemical analysis of some medicinal plants. *Journal of phytology*, *3*(12).

100. Zepernick, B. (1972). *Arzneipflanzen der Polynesier* (Vol. 8). D. Reimer.