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## Aromatic plants: Role and uses in human prosperity and sustainability

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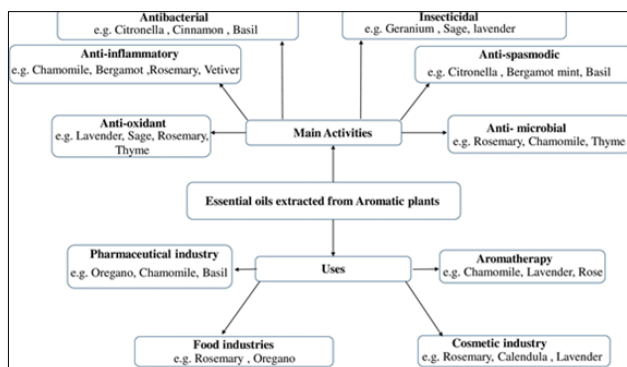
### Abstract

The history of aromatic plants dates back through many ages and civilizations and they have been used for many years to prevent, restore and aid in numerous diseases, as well as to expand the wellbeing and prosperity of the populations. Since the beginning of time, essential oils have played a pivotal role in human life, either directly or indirectly. Each aromatic plant contains a certain number of chemical compounds that differ from plant to plant. These compounds have different modes of action, such as antimicrobial, anti-parasitic, antiprotozoal, antifungal, anti-inflammatory etc. Aromatic plants are exceptionally beneficial to human culture because they are more affordable, accessible, as well as being distinctive, natural, sustainable, and normally recognized as nontoxic items. Hence, aromatic plants play a significant role in human welfare. Intensifying interest in aromatic plants gears up new revenue generating opportunities for rural inhabitants. But, these aromatic plants are not taken care of properly. In light of the foregoing realities, such aromatic plants direly need preservation by all means for future generations.

**Keywords:** Aromatic plants, human welfare, secondary metabolites, essential oil

### 1. Introduction

Plants have been the key source of healing, curing, and alleviating numerous diseases since the dawn of human civilization and they are primary source of a number of produce considered to be indispensable to mankind. Aromatic plants consists of redolent volatile substances in one or more plant parts, such as foliage, stem, root, bark, wood, flowers and fruits which appear as oleoresin, gum exudate, balsam and essential oil (Joy *et al.* 2001a,b; 2014) [40-42]. A number of complex chemical compounds are responsible for the distinctive fragrance. Each aromatic plant has a unique nature and concentration of chemical substances, which varies depending on plant species and concentration changes with plant age (Patel, 2016) [62]. These essential oils are congregated in the glandular hairs, secretion channels, cavities, and occasionally in plant oil cells (Mathe, 2015) [52]. Aromatic plants have conventionally been utilized in the perfumery and cosmetics industries owing to their rich fragrance comes from essential oils (Fig.1), which are phyto-constituents of the plants (Pandey *et al.* 2020) [61]. A lot of them are solely used also for therapeutic purposes in aroma-therapy and an array of medical systems (Maiti *et al.* 2007) [50]. Extracts of aromatic plants are used in innumerable purposes (Table 1, Figure 2).



**Fig 1:** Essential oil: Different activities and uses

Only a little over 500 species of known aromatic plants have been studied in depth, out of a total of 1500 species. Barely about a dozen of the 50 species found useful for commercial source of essential oils which are being used for regular as well as large-scale consumption (Inoue *et al.* 2017; Joy *et al.* 2014) [36, 14]. According to the Bible and the sacred Jewish

book, the Talmud, aromatic plants such as myrtle and incense were used during various ceremonies following a treatment (Dimitrova, 1999) [16]. These plants were also widely used in the form of disinfectant, drugs and as aromatic agent in ancient Persia (Hamilton, 2004) [33].

**Table 1:** Extracts of Aromatic plants

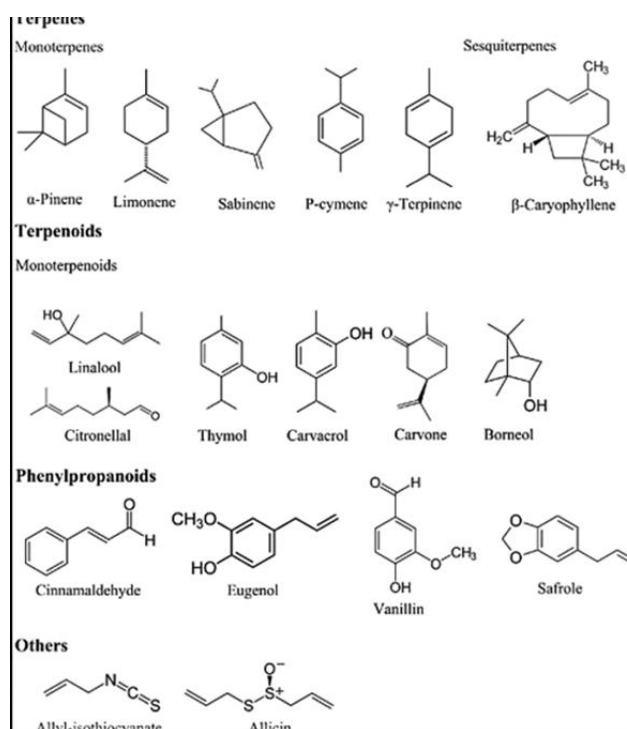
Sl. No.	Extracts	Description
I)	Tincture	Typically, a concentrated herbal extract made by dissolving different plant parts in ethanol
II)	Stimulant/tonic	A plant extract that excites the bodily function, more specifically brain and central nervous system
III)	Resins	Amorphous, solid or highly viscous substances of plant origin with a complex chemical nature
IV)	Plant extracts	Substances or extracts that are removed from different plant parts, usually in the form of essential oil
V)	Oleoresins	Homogeneous, semi-solid herbal extracts composed of resins and essential or fatty oils
VI)	Infusion	Plant extract prepared by steeping or soaking plant materials in water, oil or alcohol over time
VII)	Fixed oil	Non-volatile plant extract, a mixture of esters of fatty acids usually triglycerides
VIII)	Essential oil	Concentrated hydrophobic liquid obtained from plant parts by distillation (steam and/or water)
IX)	Decoction	A water based herbal extract, especially a medicinal preparation made by heating or boiling plant materials in water
X)	Concrete	Non-volatile semi-solid mass of a plant obtained by solvent extraction of fresh plant material
XI)	Balsam	Aromatic resinous substance that consists of a resin dispersed in benzoic acid and/or cinnamic acid esters
XII)	Absolute	Concentrated, pure and odorous extract of flowers for use in perfumes, produced through solvent extraction

Source: Leung and Foster (1996)

## 2. Aromatic Plants in Health Care: Conventional and Modern

Aromatic plants are regarded as one of the important source of medicinal constituents used in human health care primarily. Humans first realized that the entire plant or plant parts are very much useful to make sick people healthy and give relief that led to the further use and application of these plants in medicines (Inoue and Craker, 2014) [35]. Over the 18<sup>th</sup> and 19<sup>th</sup> centuries, new perceptions on the causes of ill health emerged (such as Pasteur and Koch's germ theory, Lister's use of disinfectants), but aromatic plants persisted to be the principal pharmaceutical agents into the early 1900s (Craker and Gardner, 2006) [15]. Antioxidant and antibacterial capabilities of aromatic plant has been studied extensively and proven to be advantageous in a range of health applications like prevention and reduction of various diseases i.e.

atherosclerosis, inflammation, cardiovascular and cancer (Gutteridge and Halliwell, 2010 and Ndhlala *et al.* 2010) [32, 57]. Due to substantial antioxidant properties, numerous plant families, particularly *Lamiaceae* (Ding *et al.* 2010., Dorman *et al.* 2003., Jayasinghe *et al.* 2003., Kosar *et al.* 2004 and Matsuura *et al.* 2003) [17, 18, 39, 45, 53], *Apiaceae* (Allahghadri *et al.* 2010., Bettaieb *et al.* 2010 and Thippeswamy and Naidu, 2005) [2, 10, 69] and *Zinziberaceae* (El-Ghorab *et al.* 2010., Eleazu and Eleazu, 2012 and Masuda *et al.* 2001) [21, 22, 51], have extensively been scrutinized for their therapeutic qualities. Several factors affect the antioxidant activities of aromatic plants, including growth environments, processing/extraction methods, and most specifically, antioxidants constituents (Yesil-Celiktas *et al.* 2007) [71]; as a result, the methods used to determine antioxidant capacity and extraction play a vital role (Skrovankova *et al.* 2012).



**Fig 2:** Chemical structures of different constituents present in essential oil [Source: Hyldgaard *et al.* (2012)] [34]

## 2.1 Conventional uses of aromatic plants

The use of aromatic herbs may be traced all the way back to our ancestors, who relied on natural resources found to alleviate, treat and heal their sufferings, diseases and wounds. In Eastern Europe and Iraq, archaeologists have discovered bodies wrapped in dried aromatic plants and seeds, and cave paintings also documented the existence of tribal rituals involving the burning of dried aromatic leaves or trees (Guidi and Landi, 2014) [30]. Aromatic plants such as fennel, galbanum and pine were used by the Sumerians (4000 BC), and they were the first community to use written blueprints for herbal remedies. The Egyptians (3000 BC) first led the ways in the utilization of aromatic crops as medicines. Aromatic oils have long been used in preservation of the deceased's body as mummy on their passage to the life after death. The Indians (1500 BC) first laid the foundation in ayurvedic medicine, a Hindu method of folk-traditional medicine evolved from India. The Greeks (1000 BC) contributed greatly to exploit aromatic plants as medicinal items. Hippocrates, the 'Father of Medicine,' who is recognized for protecting Athens from the plague epidemic by asking the city dwellers to burn massive urns of aromatic crops in the avenues.

## 2.2 Pharmaceutical Industry

Several reasons justify the prominent role of aromatic plants in the pharmaceutical industry. These plants are the sources of a wide range of biologically active compounds and cannot be overlooked by current medical practice due to their healing effects. They cannot, though, be synthesized because of their often unidentified characteristics and intricacy, they can still not be synthetically generated. Their synthetic manufacturing is also unreasonably costly (i.e. ergot alkaloids, cardiac glycosides, etc.)

The pharmaceutical industry regularly exploits the effective components present in aromatic plants as initial ingredients for the semi-synthetic products manufacturing (i.e. corticosteroids produced from Solanum alkaloids), or for isolation of some designated model compounds (e.g. secologanin), etc. Aromatic plants are also being used widely in the manufacturing of a number of health care goods as raw materials, items like plant cosmetics and plant safety products that are environmentally friendly (e.g. pyrethroids).

## 2.3 Aromatherapy

Aromatherapy is a supportive rehabilitation method that employs essential oils as the primary healing agents in the treatment of numerous ailments. Essential oils, usually volatile in nature, are extracted from different plant parts (roots, stems, barks, leaves, flowers, fruits etc.) using a variety of procedures/techniques. Aromatherapy has been acknowledged as a therapeutic technique since prehistoric era. It refers to a natural medicinal approach that focuses on the impact of aromatic herbs, its extracts and essences on convalescing a person's mood or health conditions. Existing scientific reports divulges that this therapy received huge consideration at the later part of twentieth century and also has been admired in the twenty-first century by virtue of its

significance, recognition, and widespread usage. Thus, it is acknowledged as aroma science therapy (Esposito *et al.* 2014) [26]. Personal hygiene, fitness and sanitation products manufacturers, as well as professionals such as nurses and doctors, chiropractors, and massage therapists use this therapy. Since certain essential oils have antimicrobials properties, they might be used to cure contagious diseases. Aromatherapy can be used in amalgamation with other supportive harmonizing therapies. The empirical facts on the pharmacological activities of essential or volatile oils and aroma chemicals (e.g. anti-inflammatory, antibacterial, expectorant, tranquillizer, etc.) have been mounting day by day (Krings and Berger, 1998; Rowe, 2004) [46, 65].

## 2.4 Phytotherapy

Phytotherapy is characterized, in the simplest manner, as the treatment of diseases by using the herbal medicines extracted from plants in a novel way. It incorporates the core principles of both conventional (ethno-medicine) as well as modern medicine, though it is represented in a different manner in various countries (Mills and Bone, 2000) [54]. Phytotherapy (use of herbal extracts) is the application of therapeutic doses of dried aromatic plant materials or extracts of various plant parts for the treatment of the exhibited signs of the diseases. Thus, it acts just equivalent to the use of traditional medicines (Barnes *et al.* 2007) [7]. Many of the medications have been prepared using plants, but at present they are either manufactured in chemical labs or reformed to perk up standardization, uniform administration and secured bioactivity of drugs (Inoue and Craker, 2014) [35].

To categorize species, compute bacterial infectivity, evaluate effectiveness, and generate analysis certificates, modern phytotherapy can use conventional approaches to appraise quality of the herbal drugs, but it is more convenient to rely on recent procedures like gas chromatography (GC), high-performance liquid chromatography (HPLC), atomic absorption spectroscopy (AAS) or ultraviolet / visible spectrophotometry (Gad *et al.*, 2013) [29]. Phytotherapy is elementarily different from homoeopathy and anthroposophical medicines in that it restricts the use of natural (plant) and synthetic bioactive agents in the same way.

## 3. Modern application of aromatic plants

As the World Health Organization (WHO) still relying on plants for the well-being of approximately 80% of the world population, especially in developing countries, the application of aromatic plants is growing worldwide (Gurib-Fakim, 2006) [31]. The aromatic plants have been transformed into industrial crops as a result of their diversified applications and the consequential increased demand for these species. They are considered as environmentally sustainable, natural and widely accepted as healthy goods (Lubbe and Verpoorte, 2011) [49]. It is evident that these compounds' antioxidant properties help to prevent diseases related to oxidative stress i.e. Alzheimer's disease, diabetes, cardiovascular disease, cancer etc (Shetty, 1997; Miron *et al.* 2010) [66, 55]. The impact of aromatic crops for treating different diseases is presented in Table 2.

**Table 2** Different aromatic plants used for various treatments

Crop	Family	Treatment	References
Basil ( <i>Ocimum spp.</i> )	Lamiaceae	Antidepressant, hepatoprotective and antidiabetic	Lahon and Das, 2011 [47]; El-Beshbishy and Bahashwan, 2012 [20]; Muralikrishnan <i>et al.</i> , 2012 [56]

Salvia ( <i>Salvia officinalis</i> L.)	Lamiaceae	Mouth and throat Inflammations and infections. Infusion and decoction are used in conventional medicine to cure wounds and relieve from stomach, liver and rheumatic pains, as well as to treat the common cold	Bayrak and Akgul, 1987 <sup>[8]</sup>
Rosemary ( <i>Rosmarinus officinalis</i> L.)	Lamiaceae	Antimicrobial, antiviral, anti-inflammatory, anti-carcinogenic properties	Begum <i>et al.</i> , 2013 <sup>[9]</sup>
Laurel ( <i>Laurus nobilis</i> L.)	Lauraceae	Traditionally, it has been used as a medicine to cure epilepsy and also to relieve haemorrhoids and rheumatic pains	Zargari, 1990 <sup>[72]</sup>
Thymus ( <i>Thymus vulgaris</i> L.)	Labiatae	Used in traditional medicine for the cure of respiratory diseases like asthma and bronchitis	Ram <i>et al.</i> , 2011 <sup>[63]</sup>
Sweet marjoram ( <i>Origanum majorana</i> L.)	Lamiaceae	Used in traditional medicine for headache, indigestion, asthma and rheumatism, beside this also used in the treatment of cramps, depression, dizziness, gastrointestinal disturbances, paroxysmal coughs and as well as acts as a diuretic drug	Jun <i>et al.</i> , 2001 <sup>[43]</sup> and El-Ashmawy <i>et al.</i> , 2005 <sup>[19]</sup>
Mentha ( <i>Mentha Spp.</i> )	Lamiaceae	Used to alleviate itching skin, muscle aching, fever, sore throat, sunburn and in nasal blockage	ESCOP, 1997 <sup>[24]</sup>
Lavender ( <i>Lavandula officinalis</i> L.)	Lamiaceae	Used as a disinfectant in swabbing of injuries, against burns and insect bites; also as a relaxant, carminative and tranquilizing agent in aromatherapy	Cavanagh and Wilkinson, 2002 <sup>[13]</sup> and Evandri <i>et al.</i> , 2005 <sup>[27]</sup>
Chamomile ( <i>Matricaria recutita</i> L.)	Asteraceae	Due to presence of an array of properties like anti-inflammatory, vulnerary, deodorant, bacteriostatic, antimicrobial, anticatarrhal, carminative, sedative, antiseptic and spasmolytic properties, helps in treating gastrointestinal troubles, including flatulence, indigestion, diarrhoea, anorexia, motion sickness, nausea and vomiting	Newall <i>et al.</i> , 1996; <sup>[59]</sup> Blumenthal, 1998 <sup>[11]</sup> and Nemezc, 1998 <sup>[58]</sup>
Wormwood ( <i>Artemisia absinthium</i> L.)	Asteraceae	Used for its antibacterial, stomachic, antifeedant, antihelminthic, antifertility, antipyretic, cytostatic, antitumour and antimalarial activities	Nin <i>et al.</i> , 1995

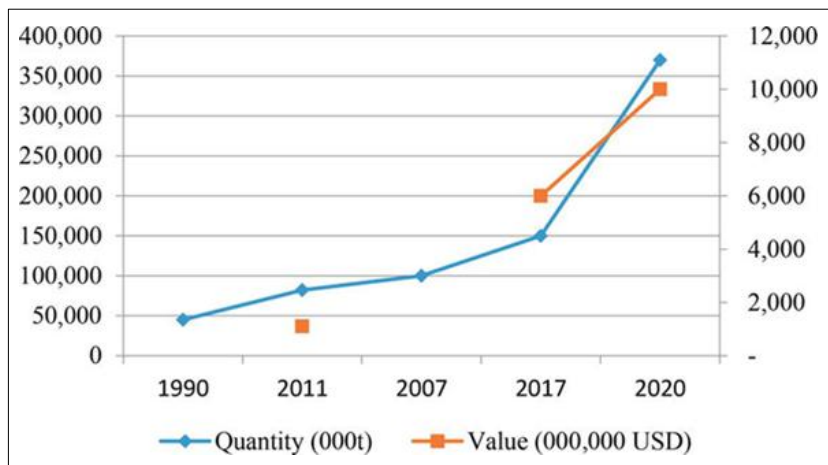
#### 4. Aromatic Plants and Its Sustainable Use

Due to presence of medicinal, nutritional and aromatic properties, approximately 60,000 species are being used globally; whereas not less than 500 million tonnes of products prepared with these species are exported every year (WHO, 2015). In 2002, a universal Plant Conservation Strategy was initiated with a long-time aim of ensuring the protection of wild flora species from becoming endangered within the foreseeable future, and that minimum 30% of all plant-derived items come from sustainable management practices. Ever-increasing requirement for MAP has resulted from augmented worldwide awareness in the usage of aromatic plants and growing demand for unprocessed materials from an assortment of manufacturing industry such as pharmaceutical, food, cosmetics, perfumery, etc. putting demands on natural sources, since the majority of the species employed for the production are still procured from the wild. The justifications why the research, assessment, usage and restoration of MAP becoming indispensable parts of escalating market programmes are unrestrained over-utilization of undomesticated plants, the loss and alteration of their habitation (Barata *et al.* 2011b) <sup>[6]</sup>. Among all the factors, over harvesting, habitat alteration and climate change are the foremost factors contributing to the loss of commercially valuable untamed plant sources which are involved in food and therapeutic-industries. Efforts to improve conservation and sustainable usage evaluation procedures and metrics are very much needed (WHO, 2015). Both the *in-situ* and *ex-situ* conservations, which are complementary conservation approaches for plant genetic resources in general and particularly for MAP species, have been implemented in

Europe and other surrounding continents all around the world.

#### 5. Essential Oil and Trade: The Symbiosis

Essential oils are characterized as capricious, odorous, hydrophobic and extremely concentrated compounds derived from many of the plant parts like roots, leaves, twigs, buds, flowers, wood, bark, fruit and seeds, and preserved in canals, cavities, secretive cells, epidermal cells and glandular trichomes (Bakkali *et al.* 2008) <sup>[5]</sup>. Terpenes and aromatic compounds are two chemical components that come through two different biosynthetic alleyways. Terpenes and terpenoids make up the majority of the group, while the remainder are aromatic and aliphatic elements, all of which are distinguished by a low molecular weight. The methods of extracting essential oils are presented in Table 3. During the era 1987-1991, imports rose from US\$ 0.838 billion in 1987 to over US\$ 1 billion in 1990, but in 1991 as a result of Gulf War knocked down to US\$ 0.984 billion (ITC, 1993b). Essential oil is expected to hit USD 11.19 billion in global market value by 2022, with a CAGR of 8.83 per cent from 2017 to 2022. The market demand is being influenced by a turn in the trend towards prevention of health issues, as well as a better living standard among customers. Increased reports of gloominess and apprehension disorders among customers are also thought to be contributing to the aromatherapy industry's growing demand towards essential oils. The market was divided according to product type, extraction process, usage and area. The international market demand for essential oils was projected to be 0.247 megatons in 2020 and it is predicted to rise at a compound annual growth rate (CAGR) of about 7.5 per cent from 2020 to 2027 (Grand view Research, 2020) <sup>[4]</sup>.



**Fig 3:** World production of essential oils (000 t; 000,000 USD) [Source: EFEO, ISMEA]

The Secretariat of the Convention on Biological Diversity reported that the global trades of herbal commodities generated an approximate US\$ 60 billion in 2002 (FAO,

2005). Thus, over the past three decades, global demand for herbal products has increased dramatically.

**Table 3:** Extraction methods of essential oil from plant species

Methods	Process for extraction essential oil
Distillation	Transformation of volatile liquids (essential oils) into vapor that is subsequently condensed back to liquid form
Water distillation	Plant tissue is completely immersed in water, which is being brought to boil by applying heat and vaporizes the essential oil
Steam distillation	Steam moved up along the plant tissue and vaporizes the essential oil
Hydro diffusion	Steam moved down through the plant tissue vaporizing essential oil from it
Expression	Plant is cold pressed to wring out essential oil from the tissue; practiced primarily for oil extraction of citrus
Sponge expression	Plant tissues are macerated and oil is pounded on top of collection sponge
Ecuelle a piquer	Tissue punched by a machine with spikes to release the essential oil
Machine abrasion	Plant tissue subjected to abrasion to eliminate oil cells and subsequently centrifuged for accumulation of essential oil
Solvent	Extraction of essential oil from plant tissue after placing the material in a solvent system
Enflourage	Plant tissue crushed into bowl of fat to extract essential or volatile oil; followed primarily for extraction from flower petals
CO <sub>2</sub> extraction	Plant parts kept in a sealed container with hypercritical carbon dioxide

Source: Soysal and Oztekin (2007) <sup>[68]</sup>; Esoteric Oils (2013)

**6. Perfumery and Cosmetic industry**

Essential oils are extensively used globally in perfume and cosmetic industries. Plant materials of aromatic plants which are used for this purpose are presented in Table 4. Herbal remedies are widely admired and plays a significant role in direct and indirect home and health care. The growing adoption and use of health-care plant-derivatives in the cosmetics industries (Aburjaiand Natsheh, 2003) <sup>[1]</sup>, as well as common man’s usage in everyday life for maintaining personal health and well-being, have led to the recognition. In accordance with a recent study in European Union Member

States, it can be specified that approximately 1400 herbal preparations are widely used. Under standard or practically predictable conditions of use, cosmetic stuffs should be safe and sound. According to Regulation E.U., 2009, risk- benefit analysis, in fact, should not be used to validate a threat to human health. Due to presence of antioxidant elements such as carotenoids, flavonoids and polyphenols, herbal extracts are commonly incorporated in cosmetic formulations as well as used tremendously for their anti-inflammatory effects on the skin (Kole *et al.*, 2005) <sup>[44]</sup>.

**Table 4:** Plant species used in the processing of perfumes

Common name	Botanical name	Common name	Botanical name	Common name	Botanical name
Aloe	<i>Aloe vera</i>	Fennel	<i>Foeniculum vulgare</i>	Myrrh	<i>Commiphora myrrha</i>
Basil	<i>Ocimum basilicum</i>	Fir	<i>Abies balsamea</i>	Nutmeg	<i>Myristica fragrans</i>
Bergamot	<i>Citrus aurantium</i>	Frankincense	<i>Boswellia carteri</i>	Patchouli	<i>Pogostemon cablin</i>
Calendula	<i>Calendula officinalis</i>	Rose geranium	<i>Pelargonium capitatum</i>	Rose	<i>Rosa species</i>
Camphor wood	<i>Cinnamomum camphora</i>	Jasmine	<i>Jasminum sambac</i>	Rosemary	<i>Rosmarinus officinalis</i>
Cardamom	<i>Elettaria car-damomum</i>	Jojoba	<i>Simmondsia chinensis</i>	Rosewood	<i>Pterocarpus indicus</i>
Cedarwood	<i>Cedrus libani</i>	Juniper berry	<i>Juniperus communis</i>	Sage	<i>Salvia officinalis</i>
Chamomile	<i>Matricaria recutita</i>	Lavender	<i>Lavandula species</i>	Sweet violets	<i>Viola odorata</i>
Cinnamon	<i>Cinnamomum verum</i>	Lemon grass	<i>Cymbopogon citrates</i>	Thyme	<i>Thymus vulgaris</i>
Clove	<i>Syzygium aromaticum</i>	Mignonette	<i>Reseda odorata</i>	Vanilla	<i>Vanilla planifolia</i>
Cucumber	<i>Cucumis sativus</i>	Mimosa	<i>Acacia dealbata</i>	Vetiver	<i>Vetiveria zizanioides</i>
Dill	<i>Anethum graveolens</i>	Mint	<i>Mentha species</i>	Ylang-ylang	<i>Cananga odorata</i>

[Sources: Bukisa (2013) <sup>[12]</sup>; Ellena (2011) <sup>[23]</sup>; Kole *et al.* (2005) <sup>[44]</sup>

## 7. Conclusion and Future Prospects

The need for aromatic plants can be anticipated to linger in the coming future, functioning as a key source of essential oils and as an alternative remedy for individuals who are more used to the traditional medications, in value addition and so on. The pharmacological properties of aromatic plants are boon to human welfare by enhancing positive global implications. The ongoing search to find out new drugs from the abundant plant species would almost certainly lead to the discovery of novel chemical components with therapeutic potential to cure diverse array of human diseases such as cough, heart diseases, respiratory disease and even nerve diseases in a sustainable way. Though the existence of these plants and their magical therapeutic impact were known from ancient times, but with the shoot up of population the cultivation and promotion of aromatic plants has been enlightened to boost the global economy, and thereby benefiting mankind. Nevertheless, intended for fruitful and consistent outcome, these plants and their inherent magical compounds require stringent standardization protocols as well as a standard method of extraction of the phytochemicals which make it possible to involve large scale industries. Rigorous research and evidence will make it more trustworthy and henceforth, prove the effectiveness of the extracts of the aromatic plants. Adopting good agricultural practices (GAP) will also create livelihood prospects. Finally, it may be concluded that as aromatic plants are less costly, easily accessible and have a rich capacity to control disorders, they will become an asset to human society by harmonizing in between the pharmaceutical as well as food and perfumery-cosmetic industry.

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