Communication in Physical Sciences, 2026, 13(2): 422-456

Essential Oils from East African *Ocimum* Species as Potential Sources of Fragrances for Cosmetic Applications: A Review

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Received: 19 December 2025/ Accepted: 30 February 2026/Published: 20 March 2026
https://dx.doi.org/10.4314/cps.v13i3.6

Abstract: *Growing concerns over the safety and sustainability of synthetic fragrances have driven interest in natural alternatives, particularly essential oils. The potential application of East African Ocimum species in cosmetics remains largely underexplored despite their rich chemical and aromatic diversity. Following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, this study systematically examined 22 peer-reviewed articles on East African Ocimum essential oils published between 1984 and 2025. Data on species, plant part used, extraction method, essential oil yield, and Gas Chromatography–Mass Spectrometry (GC–MS) profiles were retrieved from Web of Science, Scopus, Science Direct and African Journal Online (AJOL) databases and search engines such as Google Scholar. Scent profiles and potential cosmetic applications were determined based on secondary literature. A total of 10 Ocimum species including O. basilicum, O. gratissimum, O. kilimandscharicum, O. americanum, O. lamiifolium, O. kenyense, O. urticifolium, O. suave, O. sanctum and O. canum were identified. Analysis of 53 essential oils revealed the presence of monoterpenoid, sesquiterpenoid, and phenylpropanoid classes of compounds, with 28 chemotypes recorded. Fragrance profiling yielded 7 aroma families, with camphoraceous/cooling notes being the most dominant. Based on chemical, aroma and functional profiles, 36, 28, and 15 oils were considered as potential fragrance ingredients for skincare, perfume and haircare formulations, respectively. The notable chemical and aromatic diversity of these essential oils underscores their potential applications in cosmetic formulations. To support bio-based economy in meeting the rising global demand for essential oils, standardized cultivation and extraction methods should be explored to ensure chemotype consistency and yield reliability. Collectively, Ocimum species essential oils in East Africa exhibit potential as natural sources of fragrance in cosmetic formulations based on their chemical and aromatic diversity.*

Keywords: *Ocimum, Essential oils, Cosmetics, Formulations, East Africa.*

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1.0 Introduction

Fragrance is an important component of the cosmetic industry which is widely recognized as a key determinant of consumer preference by enhancing the product's appeal and perceived attractiveness. In addition, fragrance plays an important functional role in masking undesirable odors that may arise from other components used in cosmetic formulations (Copper, 1995). There are growing concerns over synthetic fragrances' related potential health risks hence the search for natural plant-derived alternatives. In particular, the use of essential oils, which are considered as sustainable and safer sources of fragrances has intensified. Increased awareness in consumer health, wellness, and environmental safety has stimulated the global expansion of the essential oils market. The expansion is driven by rising demand for natural and organic cosmetics products (Butnariu & Sarac, 2018).

According to the Council of European Union regulation, a cosmetic product is defined as any substance or mixture of substances intended to be placed in contact with the external parts of the human body, teeth as well as the oral cavity with the aim of cleaning, protecting, perfuming, improving appearance, maintaining good condition, or masking body odors (Shai *et al.*, 2009). Essential oils contain bioactive compounds which are a crucial component of cosmetic industry. They could serve as natural preservatives while offering antimicrobial, anti-inflammatory, antioxidant, and relaxant benefits for the human body. In addition, these chemical constituents have been reported to increase the value of cosmetic products due to their pleasant aroma (Sarkic & Stappen, 2018; Halla *et al*., 2018). In addition, it is well documented that essential oils provide additional benefits to the skin such as anti-acne, anti-aging (Nurzyńska-Wierdak *et al.*, 2022), skin lightening (Aumeeruddy-Elalfi *et al.*, 2018), and sun protection (Mishra *et al.*, 2012), among others, hence their high value in the cosmetic industry.

1.1 Essential Oils

Out of an estimated 3,000 known essential oils, about 150 are commercially important and are actively traded in the international markets (Barbieri & Borsotto, 2018). Essential oils are complex mixtures of compounds in concentrated extracts derived from various plant parts such as stems, leaves and flowers which give characteristic scents and flavours. Compounds in essential oils are classified based on their concentration as major compounds (≥20 to 95%), secondary compounds (1 to <20%), and trace compounds (<1%) (Boubechiche *et al*., 2017). Plants' aromas as well as their biological including analgesic properties are determined by the type and concentration of compounds present in their respective essential oils (Tongnuanchan & Benjakul, 2014; Parthasarathy *et al*., 2008; Dhifi *et al.*, 2016).

Essential oils are complex mixtures that may contain dozens or even hundreds of individual chemical constituents with chemotypic description based on one or two key compounds. The diversity of applications and biological activities exhibited by essential oils is linked to their chemotypic variation (Butnariu & Sarac, 2018). There exists a direct relationship between the chemical structure of a compound and its perceived corresponding aroma. Functional groups, molecular weight, and volatility determines the scent chemistry which in turn influences the nature and intensity of aromatic properties of a compound. Consequently, it is important to understand the chemical profile of essential oils and their effective application in the manufacture of cosmetics where both their aroma and bioactivity are of great significance (Khatib, 2024).

1.2 Ocimum Species in Africa

Genus *Ocimum* (commonly known as basil) has attracted considerable attention among the various plants being explored for natural fragrance production due to their essential oils' rich chemical and aromatic profiles (Vieira & Simon, 2006; da Costa *et al.*, 2015). The genus belongs to the Lamiaceae family which comprises of aromatic annual and perennial herbs and shrubs native to tropical regions of Asia, America and Africa (Chowdhury *et al.*, 2017). Globally, over 150 *Ocimum* species have been identified, with about 43 species reported in Africa (Paton *et al.,* 1999). *Ocimum* species exhibit a high degree of polymorphism, leading to varied chemical compositions based on origin, genetics, climatic, and cultivation factors (Gupta *et al.*, 2018). Notable regional variations resulting in multiple subspecies, varieties, and forms that produce essential oils with remarkable chemical diversity have been reported (Paton *et al*., 1999). Previous studies, across various geographical regions in Africa revealed a wide range of *Ocimum* species' essential oil chemotypes. Polymorphism has been reported in natural and cultivated populations of *O. basilicum* (Qasem *et al.*, 2023; Nganou *et al.*, 2020; Kasali *et al*., 2005; Bayala *et al*., 2014), *O. gratissimum* (Coulibaly *et al.*, 2023; Konan N'dri Séraphin *et al.*, 2022; Tonzibo *et al*., 2008; Ngassoum *et al.*, 2004), *O. americanum* (Bayala *et al*., 2014; Coulibaly *et al.*, 2023), *O. africanum* (Qasem *et al.*, 2023), and *O. canum* (Tonzibo *et al*., 2008; Ngassoum *et al*., 2004), species in Northern and Western African regions.

Several *Ocimum* species have been identified in East Africa with some growing naturally while others are cultivated for culinary and medicinal purposes (Matasyoh *et al.*, 2010). Previous studies focused on the potential application of *Ocimum* species' essential oils mainly as insect-repellents (Ochola *et al.*, 2022; Runyoro, 1998), grain protectants (Bekele & Hassanali, 2001), antimicrobial agents (Matasyoh *et al*., 2010; Runyoro, 1998; Sahalie *et al.*, 2018; Alemayehu *et al.*, 2016; Janssen *et al*., 1989), antioxidants (Matasyoh *et al.*, 2008), and bee attractants (Ngari *et al.*, 2019; Ochola *et al*., 2024). *Ocimum* species produce essential oils with pleasant scents and bioactive constituents which are reportedly used in the formulation of personal care and therapeutic products (Dharsono *et al.*, 2022). Apart from their fragrance value, *Ocimum* oils exhibit biological properties that could enhance the functional benefits and stability of cosmetic formulations (Ezeorba *et al*., 2024).

The potential use of *Ocimum* essential oils as natural sources of fragrance for the cosmetic industry remains largely underexplored. The specific biological activities and practical applications of an essential oil are dictated by its constituent compounds, hence the need for identification and quantification of these molecules (Parthasarathy *et al.*, 2008). Evaluation of the chemical composition and essential oil yield of East African *Ocimum* species presents a great opportunity for identification of natural fragrance alternatives for the cosmetic industry. Such initiatives could support the growth of East Africa's bio-based economy through sustainable utilization of indigenous botanical resources (Matasyoh *et al.*, 2010). This work explores the potential application of the East African *Ocimum* species essential oils as fragrance ingredients in various cosmetic formulations based on their documented chemical and aromatic profiles.

2.0 Methods

2.1 Search strategy

A systematic literature review was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page *et al.*, 2021). The aim of the review was to identify and analyze studies reporting the chemical composition of *Ocimum* species essential oils in East Africa. Peer-reviewed articles that met inclusion criteria were retrieved using terms: "*Chemical composition*", *"Ocimum", "essential oil"* and *"East Africa"* from key electronic databases, such as Web of Science, Scopus, Science Direct and AJOL and search engines such as Google Scholar.

2.2 Inclusion Criteria

The search strategy prioritized literature that was relevant to the study's objectives. Publications in English from the year 1984 to 2025 were considered. Eligibility criteria required that each study report a sampling location within East Africa. In addition, only studies that clearly described the extraction method and identified at least 70% of essential oil chemical constituents using Gas Chromatography-Mass Spectrometry (GC-MS) were included. Studies lacking full-text access, addressing unrelated topics, non-original publications such as reviews, letters, and commentaries, were excluded. Titles and abstracts were screened, duplicates were removed, and the remaining articles were assessed for eligibility based on the defined criteria (Snyder, 2019). Authorship rights were respected through proper citation of all included works. This systematic and selective approach ensured that the analysis was grounded in credible scientific evidence and in line with ethical research standards.

2.3 Data Extraction

Data on authorship, *Ocimum* species, sampling locations, plant parts used, extraction methods, essential oil yields and key compounds were extracted from the studies and organized in Microsoft Excel. Chemotype for each *Ocimum* species was determined based on one or two dominant compounds (Boubechiche *et al.,* 2017). Aroma profiles of the essential oils were determined from secondary literature sources that provided scent descriptions of the key compounds identified from GC-MS data. The potential applications of the oils in cosmetic formulations were evaluated based on determined aroma profiles and functional suitability of the key compounds. Data analysis captured on essential oils of the identified *Ocimum* species and the findings were summarized and tabulated.

3.0 Results and Discussion

The data used in this work was extracted from 22 studies that met the inclusion criteria. Ten *Ocimum* species were identified and a total of 53 essential oils from six East African countries including Kenya, Uganda, Tanzania, Ethiopia, Democratic Republic of Congo and Rwanda, examined. The identified species included *O. kilimandscharicum*, *O. americanum*, *O. kenyense*, *O. gratissimum*, *O. basilicum*, *O. lamiifolium*, *O. canum*, *O. sanctum*, *O. suave* and *O. urticifolium*. In some of the studies, essential oils from the same *ocimum* species in different geographical locations within the region were reported. The study reported 10, 10, 8 and 6 essential oils in *O. basilicum*, *O. gratissimum*, *O. kilimandscharicum* and *O. americanum* species, respectively (Table 1) as the most dominant species in East Africa. This observation concurs with a study by Gurav *et al*, (2022) which identified the four species as the most studied in genus *Ocimum.*

3.1 Sampling Locations, Extraction Methods, Yield, Chemotypes and Compound Classification

Findings on *Ocimum* species' essential oils' sampling location, plant part used, extraction method, yields and key classes of compounds were summarized in Table 1.

Table 1: *Ocimum* species, country of origin, sampling location, plant parts used, essential oil extraction method and yield and key classes of compounds

Ocimum species	Country of origin	Sampling location	Plant part	Extraction method	Essential oil yield	Key classes of compounds
O. basilicum	DRC	Kinshasa (Tshilanda *et al.,* 2016).	Leaves	Leaves	0.65%	MT, SQ, PP
	Ethiopia	Genet 01 WOL (Abdo *et al.*, 2021).	Leaves	Hydro distillation	0.11%	MT, SQ, PP
	Ethiopia	Genet 06 WON (Abdo *et al.,* 2021).	Leaves	Hydro distillation	0.26%	MT, SQ, PP
	Kenya	Yatta (Dambolena *et al.,* 2010).	Leaves	Hydro distillation	0.4%	MT, SQ

	Kenya	Yatta (Dambolena *et al.,* 2010).	Flowering tops	Hydro distillation	1.3%	MT, SQ
	Kenya	Sagana (Dambolena *et al.,* 2010).	Leaves	Hydro distillation	1.9%	MT
	Kenya	Sagana (Dambolena *et al.,* 2010).	Flowering tops	Hydro distillation	1.1%	MT
	Kenya	Kariti (Dambolena *et al.,* 2010).	Leaves	Hydro distillation	0.2%	MT
	Tanzania	Mbeya (Runyoro *et al.,* 2010).	Leaves Flowering tops	Hydro distillation	0.54%	MT, SQ
	Tanzania	Rungwe (Runyoro *et al.,* 2010).	Leaves Flowering tops	Hydro distillation	4.05%	MT, SQ
O. kilimandscharicum	Kenya	Nyeri (Ngari *et al*., 2019).	Leaves Flowering tops	Steam distillation	0.55%	MT, SQ, PP, NT
	Kenya	Kirinyaga (Ngari *et al.*, 2019).	Leaves Flowering tops	Steam distillation	0.35%	MT, SQ
	Kenya	Kakamega (Ochola *et al.*, 2022).	Leaves Flowering tops	Hydro distillation	3.68%	MT, SQ
	Kenya	Naivasha (Kweka *et al.,* 2009).	Leaves	Steam distillation	Not reported	MT, SQ
	Kenya	Kasarani (Mathu, 2015).	Leaves stems	Steam distillation	Not reported	MT, SQ
	Kenya	Trans-Nzoia (Mathu, 2015).	Leaves stems	Steam distillation	Not reported	MT
	Tanzania	Mbeya (Runyoro *et al.,* 2010).	Leaves Flowering tops	Hydro distillation	3.13%	MT
	Rwanda	Kibungo (Ntezurubanza *et al.,* 1984).	Leaves Flowering tops	Hydro distillation	0.5%	MT
O. grattismum	Kenya	Meru (Matasyoh *et al.,* 2008).	Leaves	Hydro distillation	0.49%	MT, SQ, PP, NT
	Kenya	Mombasa (Matasyoh *et al.,* 2008).	Leaves	Hydro distillation	1.40%	MT, SQ, PP

	Kenya	Kakamega (Ywaya *et al.*, 2020).	Leaves Flowering tops	Hydro distillation	0.12%	MT, SQ, PP, NT
	Kenya	Yatta (Dambolena *et al.,* 2010).	Leaves	Hydro distillation	2.9%	MT, SQ, PP
	Kenya	Yatta (Dambolena *et al.,* 2010).	Flowering tops	Hydro distillation	0.9%	MT, SQ, PP
	Kenya	Sagana (Dambolena *et al.,* 2010).	Leaves	Hydro distillation	0.2%	MT, SQ, PP
	Kenya	Sagana (Dambolena *et al.*, 2010).	Flowering tops	Hydro distillation	1.4%	MT, SQ, PP
	Kenya	Kitui (Muinde, 2015).	Leaves	Hydrodistil lation	Not reported	MT, SQ, PP
	Kenya	Machakos (Muinde, 2015).	Leaves	Hydro distillation	Not reported	MT, SQ, PP
	Tanzania	Muhimbili (Runyoro, 1998).	Leaves Flowering tops	Steam distillation	0.26%	MT, SQ, PP
	Uganda	Makerere (Ocheng *et al.*, 2015).	Leaves	Hydro distillation	0.21%	MT, SQ, PP
O. americanum	Kenya	Homabay (Bett *et al.,* 2022).	Leaves	Hydro distillation	0.27%	MT, SQ
	Kenya	Rachuonyo -Suba (Matasyoh *et al.,* 2006).	Leaves	Steam distillation	4.0%	MT, SQ
	Kenya	Machakos (Mathu, 2015).	Leaves stems	Steam distillation	Not reported	MT, SQ
	Kenya	Tharaka nithi (Muthengi *et al.,* 2025).	Leaves	Hydro distillation	Not reported	MT, SQ
	Kenya	Machakos (Muinde, 2015).	Leaves	Hydro distillation	Not reported	MT, SQ
	Kenya	Kitui (Muinde, 2015).	Leaves	Hydro distillation	Not reported	MT, SQ
O. suave	Tanzania	Rungwe (Runyoro *et al.,* 2010)	Leaves Flowering tops	Hydro distillation	1.15%	SQ
	Tanzania	Mbeya (Runyoro *et al.*, 2010).	Leaves Flowering tops	Hydro distillation	1.01%	PP

	Tanzania	Kimbiji (Runyoro, 1998).	Leaves Flowering tops	Steam distillation	0.6%	MT, SQ, PP
	Kenya	Tharaka nithi (Muthengi *et al.,* 2025).	Leaves	Hydro distillation	Not reported	MT, SQ
O. lamiifolium	Kenya	Nyandarua (Ngari *et al.,* 2019).	Leaves Flowering tops	Steam distillation	0.23%	MT, SQ, PP, NT
	Kenya	Nakuru (Ngari *et al.,* 2019).	Leaves Flowering tops	Steam distillation	0.29%	MT, SQ, PP, NT
	Tanzania	Rungwe (Runyoro *et al.*, 2010).	Leaves Flowering tops	Hydro distillation	3.3%	MT, SQ
	Ethiopia	Oromiya (Sahalie *et al.,* 2018).	Leaves	Hydro distillation	0.22%	MT, PP, NT
O. kenyense	Kenya	Nyeri (Ngari *et al.,* 2019).	Leaves Flowering tops	Steam distillation	0.36%	MT, SQ, PP
	Kenya	Laikipia (Ngari *et al.*, 2019).	Leaves Flowering tops	Steam distillation	0.31%	MT, SQ, PP
	Kenya	Nairobi (Bekele & Hassanali, 2001).	Leaves Flowering tops	Hydro distillation	Not reported	MT, SQ, PP
O. urticifolium	Ethiopia	Mekelle city (Alemayehu *et al.*, 2016).	Leaves	Hydro distillation	0.33%	MT, SQ, PP
	Rwanda	213C (Janssen *et al.*, 1989).	Unspecified parts	Hydro distillation	Not reported	MT, PP
	Rwanda	375I (Janssen *et al.*, 1989).	Unspecified parts	Hydro distillation	Not specified	MT, PP
O. canum	Tanzania	Muhimbili (Runyoro, 1998).	Leaves Flowering tops	Steam distillation	0.6%	MT, SQ
	Tanzania	Kimara (Runyoro, 1998).	Leaves Flowering tops	Steam distillation	0.9%	MT, SQ
O. sanctum	Ethiopia	Bishoftu (Fikadu *et al.,* 2022).	Leaves stems	Hydro distillation	Not reported	MT, SQ, NT
	Ethiopia	Debre Berhan, (Fikadu *et al.*, 2022).	Leaves stems	Hydro distillation	Not reported	MT, SQ, NT

Key: MT - Monoterpenoids, SQ - Sesquiterpenoid, PP - Phenylpropanoids, NT - Non-terpenoids

3.2 Plant Parts, Extraction Methods and Essential Oil Yields

Data collected on various studies conducted on the East African *Ocimum* species' essential oils showed variations in both yield and chemical compositions. The yields ranged between 0.12% and 4.05% with 58.5% of the sampled essential oils having yields within the previously reported range of 0.2 and 1.7% (v/w) (Vani *et al.,* 2009). However, it is important to note that data on yield of 28.3% of sampled essential oils was unavailable. Essential oils of *O. basilicum* and *O. lamiifolium* from Rungwe in Tanzania had remarkable yields of 3.3% and 4.05%, respectively. Similarly, high yields were reported in *O. americanum* and *O. kilimandscharicum* from Western part of Kenya specifically, Rachuonyo-Suba (4.0%) and Kakamega (3.68%), respectively (Table 1).

Variations in yields could be attributed to differences in the edaphic factors such as soil type (Burdina & Priss, 2016), and climatic conditions including solar irradiation, temperature and rainfall (Chang, 2005), in the study area.

Essential oil yields of *Ocimum* species have been reported to depend on the source, plant part used and developmental stage (Vani *et al.,* 2009), extraction method (Benitez *et al.*, 2009), genetic makeup and climatic conditions (Mulugeta & Radácsi, 2022). For instance, Zheljazkov *et al*. (2008) conducted a field study on 38 *O. basilicum* accessions in USA to assess essential oil yield and chemical composition. Majority of the accessions had yields ranging from 0.07% to 1.92% while most accessions had oil yields between 0.3% and 0.7% with a few outliers reaching almost 2% on dry herbage basis. This study demonstrated the significance of genetic variability in essential oil yield among *O. basilicum* accessions. While it is important to consider the yields to help provides a quantitative measure of extraction efficiency, the choice of extraction method significantly affects efficiency and the phytochemical profile of these oils.

Several extraction methods have been studied for essential oils from *Ocimum* species, with research comparing their efficiency and impact on yields and chemical composition. The most common extraction methods include steam distillation, hydrodistillation and solvent-free microwave extraction, in addition to modern techniques like microwave-assisted and supercritical fluid extraction (Ikeotuonye *et al.,* 2023). In this study, hydrodistillation was the predominant extraction technique used accounting for 71.69% of the reviewed studies (Table 1). Traditional methods like hydrodistillation and steam distillation have been reported to yield high quality oils even though they can be time consuming (Masango, 2005). Although the choice of extraction method is significant, some of the differences observed in composition could be associated with the plant parts used.

Generally, essential oils from *Ocimum* species are extracted from various plant parts, with the choice of part having significant effect on the yield and chemical composition. From literature, leaves and flowers are the primary plant parts used for essential oil extraction in *Ocimum* species, with leaves generally reported to be the richest in chemical composition and giving the highest yield (Olascuaga-Castillo *et al.,* 2024). Other plant parts such as stems, bark, seeds and roots are less frequently used depending on the plant species and the desired oil quality. In this study, essential oils obtained from leaves accounted for 41.51% of the studies, while those extracted specifically from aerial parts comprising of flowering tops, leaves, and stems represented 37.73% of the all the studies (Table 1). The predominance of studies focusing on leaves reflects their key role as the main sites of essential oil biosynthesis, owing to their relatively stable chemical composition (Kwee & Niemeyer, 2011). Leaf oils of species such as *O. basilicum* and *O. gratissimum* have been reported to be particularly rich in bioactive compounds such as linalool and eugenol, supporting their frequent use in pharmacological and antimicrobial studies (Prakash & Gupta, 2005). In *Ocimum* species, the yield and composition of essential oils are strongly influenced by flowering stage and phenological development. Essential oils extracted from aerial parts, comprising leaves, flowering tops, and stems are the most commonly used in various applications, reflecting traditional harvesting practices (Hakkim *et al.*, 2008 & Nurzyńska-Wierdak, 2013a).

3.3 Compounds in East African Ocimum Species

Chemical constituents of essential oils from various *Ocimum* species were classified into four main groups: monoterpenoids (hydrocarbon and oxygenated monoterpenes), sesquiterpenoids (hydrocarbon and oxygenated sesquiterpenes), phenylpropanoids (aromatic compounds), and non-terpenoids (aliphatic compounds). In this study, various classes of compounds were reported in the *Ocimum* species' essential oils. Monoterpenoids, sesquiterpenoids, phenylpropanoids and non terpenoids were present in substantial concentrations in 51, 43, 26 and 8 essential oils, respectively (Table 1). This observation concurs with findings of a previous study by Gurav *et al.,* (2022), which similarly reported the dominance of monoterpenoid and sesquiterpenoid compounds in the chemical profiles of the essential oils from *Ocimum* species.

3.4 Key Compounds, Fragrance Profiles and Potential Use of Ocimum Species' Essential Oils in Cosmetic Formulations

Examination of the chemical compositions of essential oils of East African *Ocimum* species revealed unique combinations of key chemical constituents that shape their characteristic scent profiles and their potential uses in cosmetics. This section presents chemotypes, key compounds, aroma profiles and potential applications of the essential oils in cosmetics based on reviewed studies and and other sources of secondary literature (Table 2).

Table 2: Key compounds, fragrance profiles and potential use of *Ocimum* essential oils in cosmetics

Ocimum species	Location	Chemotypes	Key compounds	Aroma profile	Potential use of EO in cosmetics
O. basilicum	Democratic Republic of Congo Kinshasa	Estragole-linalool	Estragole (35.72%), , Linalool (21.25%), (*E*)-*β*-Bergamotene (6.56%), Eugenol (4.6%), Eucalyptol (4.04%) (Tshilanda *et al.,* 2016)	Warm, sweet, spicy-floral aroma with subtle woody undertones and herbal hints (Spence, 2024; Sell, 2019)	Sensitive skincare creams, lotions and balms, scalp treatments (Guzmán & Lucia, 2021; Paudel *et al.,* 2025).
	Ethiopia Genet 01 WOL genotype	Bisabolene	*β*-Bisabolene (23.24%), α-Bisabolene (21.55%), Eugenol (13.96%), Estragole (13.35%), Eucalyptol (7.55%) (Abdo *et al.,* 2021).	Warm, woody aroma with sweet-anise herbal nuances (Kumari & Kumar, 2022; Sharmeen *et al.*, 2021).	Calming creams, restorative body oils, deodorants, and herbal–fresh perfumes (Guzmán & Lucia, 2021; Paudel *et al.*, 2025).

Ethiopia Genet 06 WON genotype	(E)-Methyl cinnamate - Linalool	(E)-Methyl cinnamate (47.86%), Linalool (30.28%), (Z)-Methyl cinnamate (8.28%), (E)-*β*-Bergamotene (3.27%) (Abdo *et al.,* 2021).	Warm, sweet, floral-spicy with balsamic hints (Spence, 2024).	Perfumes, body mists, creams, lotions, and aromatherapeutic balms) (Shai *et al.,* 2009; Khatib, 2024).
Tanzania Mbeya	E-myroxide	E-myroxide (19.6%), Caryophyllene oxide (11.4%), Humulene epoxide II (11.0%), α-Copaene (7.5%), α-Humulene (6.28%) (Runyoro *et al.*, 2010).	Warm, woody-resinous scent with soft spicy-balsamic nuances (Van Opstaele *et al.*, 2013).	Perfumes, colognes, soothing lotions, creams, and soaps (Paudel *et al.*, 2025; Tran *et al.,* 2015).
Tanzania Rungwe	Eucalyptol	Eucalyptol (54.3%), *β*-Pinene (8.15%), α-Terpineol (6.6%), α-Pinene (4.39%)) α-Humulene (3.55%), α-Copaene (3.01%) (Runyoro *et al.,* 2010).	Fresh, herbal, slightly minty aroma with resinous woody hints (Sell, 2019; Sharmeen *et al.,* 2021).	Soaps, shower gels, shampoos, deodorants, facial cleansers, antiseptic lotions, acne care and scalp treatments (Guzmán & Lucia, 2021; Paudel *et al.,* 2025).
Kenya Yatta L	Camphor - Linalool	Camphor (32.6%), linalool (28.2%), Terpinen-4-ol (12.0%), (E)-*β*-Caryophyllene (5.1%), Aromandrene (4.3%) (Dambolena *et al.*, 2010).	Moderate camphoraceous, floral aroma with herbal-woody undertones (Sell, 2019; Chen *et al.,* 2013).	Insect repellent sprays, massage oils, shampoos and deodorants (Shai *et al.*, 2009; Khatib, 2024).
Kenya Yatta FT	Camphor - Linalool	Camphor (31.0%), Linalool (29.3%), Terpinen-4-ol (9.0%), Limonene (4.7%), α-Humulene (4.5%) (Dambolena *et al.*, 2010).	Moderate camphoraceous, floral aroma with herbal nuance and citrusy-woody hints (Kumari & Kumar, 2022; Chen *et al.*, 2013).	Insect repellent sprays, massage oils, shampoos and deodorants (Khatib, 2024; Opiyo, 2022).
Kenya Kariti	Geranial-Neral	Geranial (49.6%), Neral (30.9%), Citronellol (6.5%), Geraniol (3.7%) (Dambolena *et al.*, 2010).	Strong, fresh, lemony-citrus aroma with sweet, rosy nuances and floral hints (Sell, 2019; Sharmeen *et al.*, 2021).	Perfumes, body mists, deodorants, creams, lotions (Sarkic & Stappen, 2018)
Kenya Sagana L	Linalool	Linalool (95.7%) (Dambolena *et al.*, 2010).	Sweet floral and fresh citrus aroma (Sharmeen *et al.,* 2021).	Perfumes, lotions, creams, soaps, body shampoos (Paudel *et al.*,

					2025; Juergens, 2014).
	Kenya Sagana FT	Linalool	Linalool (98.9%) (Dambolena *et al.*, 2010).	Sweet floral and fresh citrus aroma (Sharmeen *et al.*, 2021).	Perfumes, lotions, creams, soaps, shampoos (Khatib, 2024).
O. kilimandscharicum	Kenya Nyeri	Camphor	Camphor (27.36%), Eucalyptol (12.29%), Limonene (4.25%), Terpinolene (4.56%), Linalool (4.17%) (Ngari *et al.,* 2019).	Mild camphoraceous, minty aroma with subtle citrusy and floral hints (Sharmeen *et al.,* 2021; Chen *et al.,* 2013).	Deep cleansing creams and moisturizers (Khatib, 2024; Duda-Madej *et al.,* 2024).
	Kenya Kirinyaga	Camphor	Camphor (21.15%), Geraniol (14.5%), Limonene (5.55%), (*E*)-*β*-Caryophyllene (5.48%), β-Myrcene (5.14%) (Ngari *et al.,* 2019).	Mild camphoraceous, aroma with rosy-floral and citrusy-woody-spicy nuances (Sharmeen *et al.*, 2021; Chen *et al.*, 2013).	Medicated soaps, bath oils and lotions (Duda-Madej *et al.*, 2024; Fajdek-Bieda *et al.*, 2025).
	Kenya Kakamega	Camphor	Camphor (36.58%), Limonene (18.61%), Camphene (7.14%), Linalool (4.32%), Terpinen-4-ol (3.90%) (Ochola *et al.*, 2022).	Moderate camphoraceous cooling scent with citrus undertone and soft floral hints (Sharmeen *et al.*, 2021; Chen *et al.*, 2013).	Insect repellent sprays massage oils and deodorants (Ochola *et al.*, 2022; Opiyo, 2022).
	Kenya Naivasha	Camphor	Camphor (70.4%), (*Z*)-*β*-Ocimene (7.2%), Limonene (6.2%), Camphene (5.1%), (*E*)-*β*-Caryophyllene (2.8%) (Kweka *et al.*, 2009).	Sharp camphoraceous, aroma with fruity-floral, herbal nuances and spicy-woody hints (Sharmeen *et al.*, 2021; Chen *et al.*, 2013).	Medicated muscle balms, rubs and liniments (Ligare, 2010).
	Kenya Kasarani	Camphor	Camphor (36.1%), Limonene (21.12%), Camphene (5.65%), Terpinen-4-ol (4.82%), Linalool (2.00%) (Mathu, 2015).	Moderate camphoraceous aroma with citrusy highlight, herbal nuance and floral hints (Sharmeen *et al.*, 2021; Chen *et al.*, 2013).	Insect repellent sprays, massage oils, footcare formulations and deodorants (Ochola *et al.,* 2022; Opiyo, 2022).
	Kenya Trans-Nzoia	Camphor	Camphor (45.51%), Camphene (13.58%), Linalool (4.93%) and Terpinen-4-ol (4.52%) (Mathu, 2015).	Strong camphoraceous pine-like aroma with herbal-floral hints (Sharmeen	Insect repellent sprays, massage oils, footcare formulations and deodorants

				et al., 2021; Chen *et al.,* 2013).	(Ochola *et al.,* 2022).
	Rwanda Kibungo	Camphor	Eucalyptol (62.2%), Limonene (12.8%), *β*-Pinene (5.2%), α-Pinene (2.8%) (Ntezurubanza *et al.*, 1984).	Intense camphoraceous aroma with citrusy and pine-like undertones (Kumari & Kumar, 2022; Sharmeen *et al.,* 2021).	Medicated muscle balms, rubs and liniments (Ligare, 2010).
	Tanzania Mbeya	Eucalyptol	Camphor (52.4%), Eucalyptol (14.3%), Limonene (7.13%), Camphene (5.36%), Terpinen-4-ol (3.24%) (Runyoro *et al.*, 2010).	Strong camphoraceous aroma with cooling undertones, citrusy-herbal nuances (Sharmeen *et al.*, 2021; Chen *et al.,* 2013).	Insect repellent sprays massage oils, footcare formulations and deodorants (Ochola *et al.,* 2022; Opiyo, 2022).
O. grattismum	Kenya Meru	Eugenol	Eugenol (68.81%), Methyl eugenol (13.21%), (*Z*)-*β*-Ocimene (7.47%), Germacrene-D (4.25%) (Matasyoh *et al.*, 2008).	Warm spicy-sweet clove aroma with floral-fruity undertones and woody hints (Spence, 2024; Sell, 2019).	Perfumes, mouth washes antiseptic, soaps, lotions, creams and balms (Shai *et al*., 2009; Guzmán & Lucia, 2021)
	Kenya Mombasa	Eugenol	Eugenol (74.14%), Germacrene-D (8.75%) (*Z*)-*β*-Ocimene (6.00%), (*E*)-*β*-Caryophyllene (3.70%) (Matasyoh *et al.,* 2008).	Warm spicy-clove like aroma with floral-fruity balsamic depth and fresh green undertones (Sell, 2019; Sharmeen *et al*., 2021).	Perfumes, medicated soaps, anti-oxidant lotions, moisturizers and healing creams (Guzmán & Lucia, 2021).
	Kenya Kakamega	Z-(*β*)-ocimene-Eugenol	(*Z*)-*β*-Ocimene (29.73%), Eugenol (21.6%), Germacrene-D (9.65%), (*E*)-*β*-Caryophyllene (5.86%), Linalool (4.13%) (Ywaya *et al.,* 2020).	Fresh, floral, spicy fragrance with woody undertones and floral hints (Sharmeen *et al.*, 2021; Zviely & Li, 2013).	Aromatherapeutic balms, soothing lotions, haircare shampoos, antiaging creams and perfumes (Guzmán & Lucia, 2021).
	Kenya Machakos	(E)-*β*-Caryophyllene	(*E*)-*β*-Caryophyllene (23%), α-Copaene (19%), Methyl isoeugenol (17%), (*Z*)-*β*-Ocimene (5%), Germacrene-D (3%) (Muinde, 2015).	Warm, spicy, aroma with resinous sweet clove-like nuances and woody hints (Spence, 2024).	Perfumes, scented lotions, soaps, and haircare oils (Khatib, 2024).

Kenya Kitui	Z-(*β*)-ocimene-Eugenol	Eugenol (30%), Isoeugenol (10%), (*E*)-*β*-Caryophyllene (8%), Methyl spirolepechinene (6%), Germacrene-D (3%) (Muinde, 2015).	Warm, sweet, spicy clove-like aroma with woody and balsamic nuances (Spence, 2024; Sharmeen *et al.,* 2021).	Perfumes, scented creams, lotions, soaps, and haircare shampoos (Guzmán & Lucia, 2021).
Kenya Yatta L	Eugenol	Eugenol (70.1%), α-Humulene (11.9%), (E)-*β*-Farnesol (5.5%), (E)-*β*-Terpineol (2.7%) (Dambolena *et al.*, 2010).	Warm, spicy, clove-like aroma with woody nuances and herbal hints (Sharmeen *et al.*, 2021).	Perfumes, medicated soaps and creams (Sarkic & Stappen, 2018)
Kenya Yatta FT	Eugenol	Z-(*β*)-Ocimene (34.1%), Eugenol (33.2%), Camphor (8.5%), Linalool (7.5%), α-Humulene (6.0%) (Dambolena *et al.*, 2010).	Fresh sweet spicy clove-like aroma with floral camphoraceous and woody undertones (Sharmeen *et al.*, 2021; Zviely & Li, 2013).	Perfumes, soaps, lotions and creams (Sarkic & Stappen, 2018)
Kenya Sagana L	Eugenol	Eugenol (95.5%) (Dambolena *et al.*, 2010).	Strong, warm, spicy, clove-like aroma (Sharmeen *et al.*, 2021)	Perfumes, soaps, creams, and lotions (Sarkic & Stappen, 2018)
Kenya Sagana FT	Eugenol	Eugenol (64.4%), *β*-Bisabolene (10.2%), (Z)-γ-Bisabolene (6.9%), (Z)-*β*-Ocimene (2.7%), (*E*)-*β*-Caryophyllene (2.2%) (Dambolena *et al.*, 2010).	Warm, spicy, clove-like aroma with woody nuances and sweet fruity hints (Sharmeen *et al.*, 2021; Zviely & Li, 2013).	Perfumes, soaps, lotions, and creams (Sarkic & Stappen, 2018)
Tanzania Muhimbili	Eugenol	Eugenol (46.9%), (*Z*)-β-Ocimene (12.0%), Linalool (2.9%), α-Farnesene (2.6%) (Runyoro, 1998).	Warm, spicy, clove aroma with sweet fruity nuance and, soft floral woody hints (Sharmeen *et al.,* 2021; Zviely & Li, 2013).	Perfumes, deodorants, acne and scalp care oils (Guzmán & Lucia, 2021).
Uganda Makerere	Eugenol	Eugenol (56.4%), *β*-Cubebene (10.9%), (*E*)-*β*-Ocimene (7.6%), α-Farnesene (5.5%), (*Z*)-*β*-Ocimene (3.7%), (Ocheng *et al.*, 2015).	Warm, spicy clove aroma with woody and sweet fruity nuances (Sharmeen *et al.*, 2021; Zviely & Li, 2013).	Perfumes, deodorants, acne and scalp care cleansers, soaps, lotions (Khatib, 2024)

O. americanum	Kenya Homabay	α-Pinene-Umbellone	α-Pinene (13.8%), Umbellulone (12.66%), δ-Cadinene (7.47%), Limonene (6.64%), γ-Cadinene (4.79%), (Bett *et al.,* 2022).	Minty-camphoraceous bright aromas with citrusy and balsamic nuances (Kumari & Kumar, 2022).	Acne-care lotions, muscle rubs, soothing creams (Guzmán & Lucia, 2021).
	Kenya Rachuonyo -Suba	Terpinen-4-ol	Terpinen-4-ol (43.21%), Eucalyptol (16.13%), (*E*)-*β*-Caryophyllene (3.06%) α-Terpineol (4.01%), Linalool (1.42%) (Matasyoh *et al.*, 2006).	Fresh, herbal and floral scent with warm woody undertones (Kumari & Kumar, 2022).	Antiseptic creams, balms, aftershave lotions, soaps and mouth washes (Khatib, 2024; Sharmeen *et al.,* 2021).
	Kenya Machakos	Eucalyptol-Linalool	Eucalyptol (39.39%), Linalool (22.25%), Terpinen-4-ol (3.87%), (*E*)-*β*-Caryophyllene (2.54%) (Mathu, 2015).	Fresh-floral and camphoraceous scent with woody undertones (Sell, 2019).	Soothing creams, soaps, mouth washes, scalp treatments and perfumes (Khatib, 2024).
	Kenya Tharaka Nithi	Eucalyptol	Eucalyptol (25.96%), Linalool (6.54%), α-Terpineol (5.91%), β-Pinene (4.18%), Sabinene hydrate (2.77%) (Muthengi *et al.*, 2025).	Fresh, camphoraceous aroma with herbal floral nuances and woody hints (Kumari & Kumar, 2022).	Soaps, shampoos, body lotions, shower gels, massage oils and deodorants (Sarkic & Stappen, 2018)
	Kenya Machakos	Eucalyptol	Eucalyptol (21%);) Linalool (22%), α-Terpenol (17%) *β*-Pinene (5%), *E*)-*β*-Caryophyllene (6%) (Muinde, 2015).	Fresh, camphoraceous aroma with herbal highlights and resinous woody nuances (Sell, 2019; Sharmeen *et al.*, 2021).	Perfumes, lotions, creams, deodorants, shampoos, and cleansing products (Sarkic & Stappen, 2018)
	Kenya Kitui	Linalool-Eucalyptol	Eucalyptol (38%); α-Terpenol (7%); Terpenen-4-ol (8%), *β*-Pinene (9%) (*E*)-*β*-Caryophyllene (6%) (Muinde, 2015).	Fresh, cool camphoraceous aroma with resinous and woody nuances (Kumari & Kumar, 2022; Sharmeen *et al.*, 2021).	Shampoos, body washes, lotions, creams, and deodorants (Guzmán & Lucia, 2021; Sharmeen *et al.,* 2021).
O. suave	Kimbiji, Tanzania	Germacrene-D	Eugenol (52.4%) (*E*)-β-Ocimene (10.7%), (*Z*)-β-Ocimene (7.9%), (Runyoro, 1998).	Warm, spicy, clove-like aroma with fresh green, herbaceous	Acne care products, hair shampoos, scalp treatments,

				nuances (Sharmeen *et al.,* 2021; Zviely & Li, 2013).	foot sprays, deodorants (Sarkic & Stappen, 2018)
	Tanzania Rungwe	Methyl eugenol	Germacrene-D (29.2%), Germacrene-B (14.8%), Caryophyllene oxide (4.13%), *β*-Eudesmol (3.11), δ-Cadinene (3.04%) (Runyoro *et al*., 2010).	Warm, woody-spicy and earthy aroma, with warm balsamic and resinous undertones (Kumari & Kumar, 2022).	Creams, lotions, anti-aging serums, hair conditioners, massage oils, perfumes and lip balms (Guzmán & Lucia, 2021).
	Tanzania Mbeya	Eugenol	Methyl eugenol (82.7%), Caryophyllene oxide (4.13%), Linalool (1.21%) (Runyoro *et al.,* 2010).	Sweet, spicy, clove-like aroma with woody floral hints (Spence, 2024).	Perfumes, lotions, creams, soaps, shampoos, hair conditioners (Sarkic & Stappen, 2018).
	Kenya Meru	Bisabolene	β-Bisabolene (11.2%), Geranial (9.40%), (*E*)-*β*-Caryophyllene (5.86%), Neral (5.77%), Isoelemicin (5.65%) (Muthengi *et al.,* 2025).	fresh, citrusy aroma, with warm, woody-balsamic and spicy undertones (Sell, 2019; Sharmeen *et al.*, 2021).	Perfumes, lotions, shampoos, soaps, and deodorants (Sarkic & Stappen, 2018).
O. lamiifolium	Kenya Nyandarua	α-Phellanderene	α-Phellandrene (13.01%), (*E*)-2-Octenyl acetate (6.42%), 2-Ethyl hexan-1-ol (5.13%), Germacrene-A (7.16%), α-Cadinene (5.23%), (*Z*)-*β*-Ocimene (4.98%) (Ngari *et al.*, 2019).	Fresh, green-citrusy aroma with fruity-sweet and a warm, woody-spicy nuance (Porat *et al.*, 2016).	Calming Body Lotion, Hair Serum, Soothing Facial Mist, (Lodén & Maibach, 2005).
	Kenya Nakuru	α-Phellanderene	α-Phellandrene (12.36%), (*E*)-2-Octenyl acetate (7.52%), (*Z*)-*β*-Ocimene (4.70%), Germacrene-A (7.88%), Epi-cubebol (6.01%), (*E*)-*β*-Caryophyllene (5.29%) (Ngari *et al.*, 2019).	Fresh, green-citrusy aroma with fruity-sweet top notes and a warm, woody-spicy undertone (Butnariu, 2021).	Perfumes, body sprays, creams, lotions, serums, and haircare oils (Shai *et al.*, 2009; Thangaleela *et al.,* 2022).
	Ethiopia Oromiya	Linalool-Octenyl propionate	Linalool (28.52%), Octenyl propionate (20.82%), Geraniol (12.14%), Verbenol (7.03%), Camphene (6.75%), γ-Cadinene (5.01%) (Sahalie *et al.,* 2018).	Floral-citrus aroma with fruity-sweet highlights and a herbal-woody undertone (Sharmeen *et al.,* 2021).	Perfume, skincare creams, lotions, scalp-care shampoos, hair serums, leave-in conditioners (Fajdek-Bieda *et al*., 2025;

					Damasceno *et al.*, 2025).
	Tanzania Rungwe	Bornyl acetate	Bornyl acetate (30.3%), *p*-Cymene (11.4%), Camphene (5.91%), α-Pinene (5.70%), *β*-Pinene (4.2%) (Runyoro *et al.*, 2010).	Fresh, camphoraceous-pine aroma with citrusy and herbal undertones (Sharmeen *et al.*, 2021; Matsubara *et al.,* 2011).	Soaps, shampoos, creams, lotions (Shai *et al.*, 2009; Guzmán & Lucia, 2021).
O. kenyense	Kenya Nyeri	Estragole-Eucalyptol	Eucalyptol (20.24%), Estragole (22.19%), *β*-Bisabolene (14.18%), *α*-Humulene (10.37%), Chavicol (6.74%) (Ngari *et al.,* 2019).	Fresh, sweet herbal-anise aroma with soft spicy, camphoraceous and woody undertones (Spence, 2024; Kumari & Kumar, 2022)	Anti-acne cleansers deodorants, foot sprays, aftershave creams and spa oils (Khatib, 2024; Bolouri *et al.*, 2022)
	Kenya Laikipia	Estragole-Eucalyptol	Estragole (35.06%), Eucalyptol (24.61%) *β*-Myrcene (6.60%), Chavicol (6.68%), *β*-Bisabolene (4.23%) (Shai *et al.*, 2009)	Sweet anise aroma with cooling herbal highlights and woody hints (Spence, 2024; Kumari & Kumar, 2022)	Perfumes, body washes, soaps, rinse-off hair shampoos (Khatib, 2024; Guzmán & Lucia, 2021)
	Kenya Nairobi	Eucalyptol-Selinene	Eucalyptol (36.96%), *β*-Selinene (23.07%), Estragole (12.86%), Iso-eugenol (8.23%), (Bekele & Hassanali, 2001).	Fresh, cooling herbal aroma with sweet, spicy highlights and woody undertones. (Spence, 2024).	Soaps, deodorants, soothing creams and lotions (Khatib, 2024; Sharmeen *et al.*, 2021).
O. urticifolium	Ethiopia Mekelle city	α-Pinene-Eugenol	*α*-Pinene (22.1%), Eugenol (21.1%), *α*-Cubebene (13.09%), *α*-Bisabolene (9.94%), *α*-Copaene (9.39%), (E)-*β*-Caryophyllene (7.77%), (Alemayehu *et al.*, 2016).	Fresh, piney-woody aroma with warm, spicy, and balsamic undertones (Sell, 2019; Sharmeen *et al.*, 2021). .	Perfumes, scented soaps, shampoos, body washes, after-sun gels, restorative creams, facial cleansers, hair tonics, body washes (Khatib, 2024; Sharmeen *et al.*, 2021).

	Rwanda 213 C	(Z)-Methyl isoeugenol	(Z)-Methylisoeugenol (35.6%), E-β-Ocimene (13.5%), Z-β-Ocimene (12.6%) (Janssen *et al.,* 1989)	Sweet, spicy-clove aroma with bright, fresh, and green-citrus undertones (Spence, 2024; Zviely & Li, 2013).	Perfumes, scented creams, lotions, soaps, and haircare products (Shai *et al.,* 2009; Sharmeen *et al.*, 2021).
	Rwanda 375 I	Z-β-Ocimeee -Eugenol	(Z)-β-Ocimene (41.0%), Eugenol (39.4%) (Janssen *et al.,* 1989)	Sweet, spicy-clove aroma with fresh, green-citrus highlights (Kumari & Kumar, 2022; Zviely & Li, 2013).	Perfumes, soaps, lotions, and aromatherapeutic balms (Fajdek-Bieda *et al.*, 2025; Bolouri *et al.,* 2022).
O. canum	Tanzania Muhimbili	Ocimenyl oxide	Ocimenyl oxide (60.0%), β--Pinene (5.8%), (E)-β-Caryophyllene (3.9%), α-Terpineol (3.3%), β--Myrcene (2.6%) (Runyoro, 1998).	Fresh, green-herbaceous aroma with piney, woody, and floral undertones (Sharmeen *et al.*, 2021; Zviely & Li, 2013).	Perfumes, soaps, balms deodorants, aftershave creams, skin cleansers, scalp-care products (Guzmán & Lucia, 2021; Bolouri *et al.*, 2022).
	Tanzania Kimara	Eucalyptol-Geranyl acetate	Eucalyptol (14.7%), Geranyl acetate (13.2%) Linalool (9.2%), Geraniol (8.5%), Geranial (6.0%), Neral acetate (6.3%) (Runyoro, 1998).	Fresh, camphoraceous–citrus aroma with floral-sweet and fruity undertones. (Kumari & Kumar, 2022; Sharmeen *et al.*, 2021).	Deodorants, foot-care products, anti-dandruff shampoos, moisturizing creams, lotions, after-sun products (Fajdek-Bieda *et al.,* 2025; Bolouri *et al.,* 2022).
O. sanctum	Ethiopia Bishoftu	Bisabolene	(E)-α-bisabolene (24.5%), (Z)-α-bisabolene (19.6%), Eucalyptol (13.4%), Estragole (6.07%), Eincosane (8.89%), Eugenol (5.79%) (Fikadu *et al.,* 2022).	Warm, sweet-woody aroma with fresh, camphoraceous and subtly spicy-clove undertones ; (Kumari & Kumar, 2022; Sharmeen *et al.*, 2021).	Calming sensitive skincare creams and lotions, perfumes, protective balms, perfumes (Guzmán & Lucia, 2021; Reddy *et al.*, 2025).
	Ethiopia Debre Berhan	Bisabolene	(E)-α-Bisabolene (31.38%) (Z)-α-Bisabolene (25.56%), Eucalyptol (17.1%), Estragole (7.48%), Eugenol (5.64%), (E)-β-Bergamotene	Warm, sweet-woody aroma with fresh, camphoraceous and spicy-clove undertones. (Sell, 2019; Sharmeen *et al.*, 2021).	Perfumes, soaps, shampoos, calming formulations, after-sun creams, deodorants, foot sprays (Guzmán & Lucia, 2021;

	(2.32%) (Fikadu *et al.*, 2022).	Reddy *et al.*, 2025).

3.4.1 Chemotypes of East African Ocimum Species

Essential oil chemotypes arise when plants of the same species exhibit variation in the composition and concentration of their chemical constituents (Spence, 2024). A total of 28 chemotypes of *Ocimum* species were identified in this study (Table 1). The high number of chemotypes demonstrates the rich diversity of *Ocimum* species found in East Africa. This could be attributed to a high degree of polymorphism exhibited by the genus which gives varied chemical compositions based on genetic makeup, origin, climate, and cultivation factors (Silvestre & Pauletti, 2021). Variation in the number of chemotypes was observed across genus with *O. basilicum* having the highest at 9 (Fig. 1). This observation concurs with Gurav *et al.*, (2022) who reported existence of 76 chemotypes of *O. basilicum* globally pointing to the species high susceptibility to polymorphism. Eugenol, camphor, eucalyptol and bisabolene were the most dominant chemotypes reported in 9, 7, 4 and 4 essential oils, respectively across the various *Ocimum* species (Table1). This underscores the critical role of secondary metabolite biosynthesis in shaping chemotypes and defining distinct essential oil profiles (Paudel *et al.*, 2025).

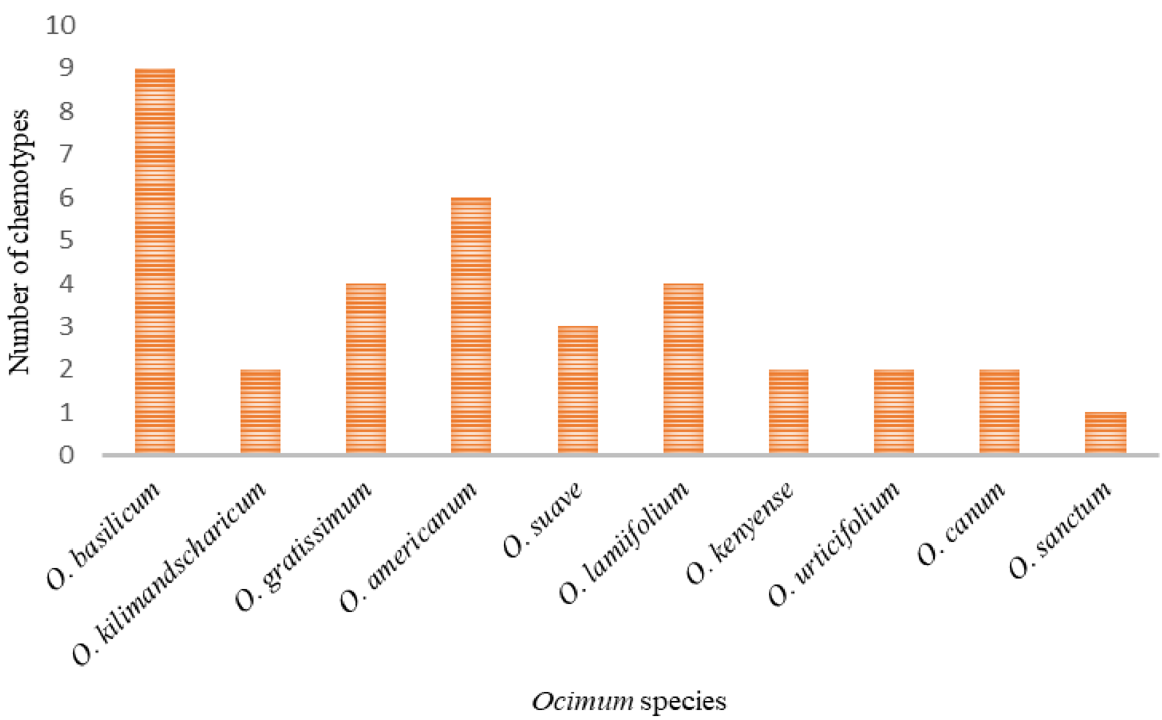

Fig. 1: The number of chemotypes per *Ocimum* species

3.4.2 Key Compounds in East African Ocimum Essential Oils

Ocimum essential oils are known to exhibit considerable qualitative and quantitative variations. These oils are typically dominated by a relatively small number of major constituents that define their distinct chemotypes and determine their aroma properties as well as potential applications. Identifying the key compounds present in *Ocimum* essential oils is therefore an important factor in understanding their aroma profiles, bioactivities and suitability for industrial applications (Nurzyńska-Wierdak, 2013b). Chemical diversity of the *Ocimum* species was observed in this study with each of the 12 chemical constituents occurring in at least 6 of all examined essential oils. Eucalyptol, linalool and eugenol were the most dominant compounds reported in 18, 16 and 16 essential oils from East African region, respectively (Fig. 2).

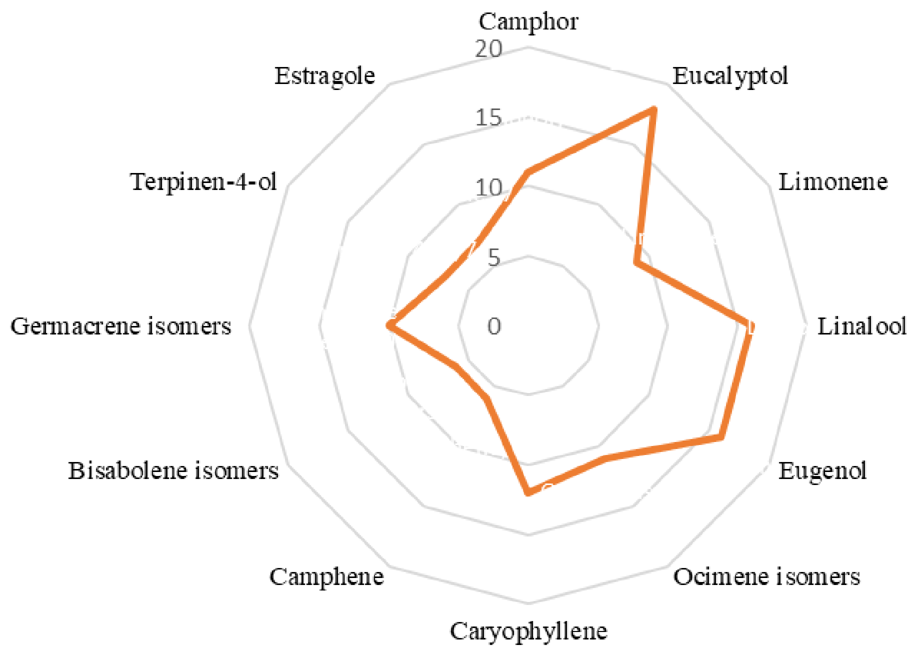

Fig. 2: Occurrence of key compounds in East African *Ocimum* species' essential oils

The occurrence of these compounds highlights the dominance of oxygenated monoterpenes (eucalyptol- and camphor-based) and phenylpropanoid (eugenol-based) chemotypes among East African *Ocimum* species. The finding reflects both regional genetic diversity and environmental influences such as climate on chemotypes (Kwee & Niemeyer, 2011). This chemical pattern is consistent with the traditional medicinal and insect repellent uses of *Ocimum* species in the region. Chemical constituents such as eucalyptol and camphor are associated with antimicrobial and respiratory applications, while eugenol exhibits strong antioxidant and antiseptic activities (Prakash & Gupta, 2005; Pandey *et al.*, 2014).

3.4.3 Aroma Profiles of East African Ocimum Species Essential Oil

The aroma profiles of the essential oils are highly diverse and are directly determined by their dominant chemical constituents. All the 53 examined essential oils exhibited a wide range of aromas with complex highlights, nuances, undertones and hints (Table 2). A total of 7 aroma families were identified in the species' essential oils with camphoraceous/cooling and warm, sweet, spicy-floral/clove-like being the most dominant (Fig. 3).

The various aroma profiles are largely driven by the relative abundance of oxygenated monoterpenes (camphor, eucalyptol and linalool) and phenylpropanoids (eugenol and estragole), among others (Table 2). The diversity of aroma profiles supports the wide range of potential industrial applications of *Ocimum* essential oils and plays a key role in determining their suitability for cosmetic formulations. Consequently, understanding aroma the variation is essential for the potential utilization of *Ocimum* essential oils across different cosmetic applications.

3.4.4 Potential Uses of Specific East African Species in Cosmetic Formulations

Due to their pleasant aroma profiles, bioactivities and natural origin, *Ocimum* essential oils show strong potential for application in cosmetic formulations. The distinct fragrance of *Ocimum* species is predominantly influenced by collective contribution of monoterpenoid, sesquiterpenoid and phenylpropanoid compounds which together form a major component of the essential oils rich aroma diversity (Pampoulie & Lambret, 2020). In addition, their aroma and biological activities supports of *Ocimum* essential oils' use as functional cosmetic ingredients. Beyond promoting skin comfort, they also act as preservatives by protecting formulations against microbial contamination (Sarkic & Stappen, 2018; Guzmán & Lucia, 2021).

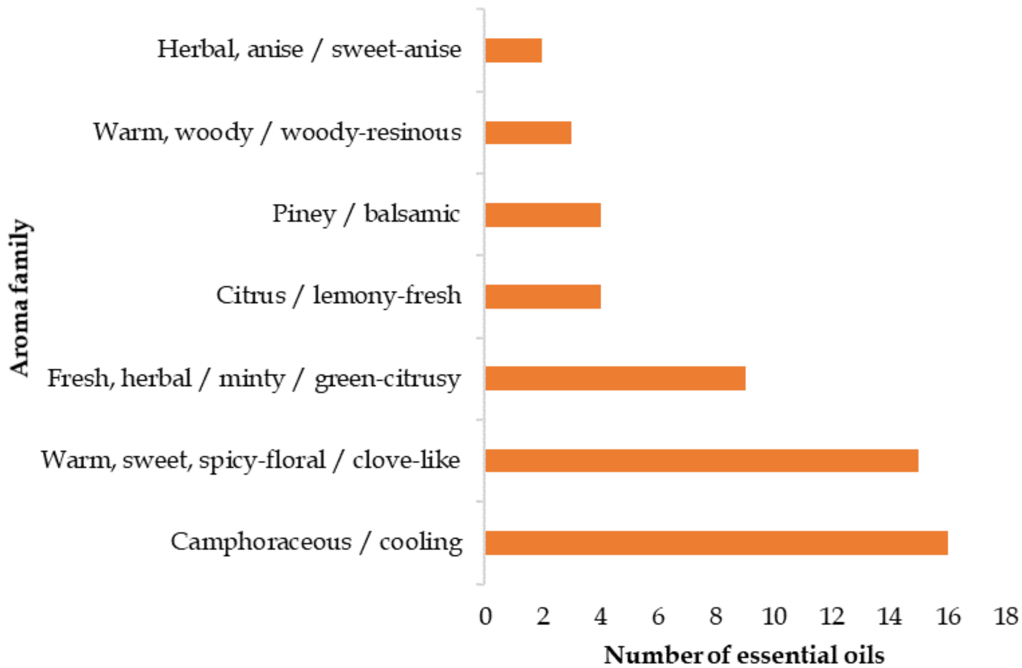

Fig. 3: The number of East African *Ocimum* species' essential oils per aroma family

In a recent study, Mosquera & Acosta (2025), reported successful incorporation of *O. basilicum* essential oil into a topical facial toner to provide stability, and consumer acceptance as well as antibacterial activity against *Propionibacterium acnes*. This highlights the real applicability of the species in the cosmetic industry. From this review, 37, 32, 21 and 15 essential oils demonstrated potential for incorporation into skincare, perfume, deodorant and haircare formulations, respectively. Collectively, 17 essential oils exhibited potential for application in insect repellent balms, footcare, oralcare and body relaxing formulations (Fig. 4).

Essential oils rich in eugenol, camphor, and eucalyptol are known to be effective as natural insect repellents, as these compounds have been reported to deter mosquitoes and other insects while providing a cooling and soothing sensation when applied topically (Sutthanont *et al.,* 2022). This study demonstrated that East African *Ocimum* species could provide important multifunctional fragrance ingredients for cosmetic formulations due to their diverse chemical, aromatic and functional profiles. However, their effective incorporation into cosmetics requires careful consideration of concentration, formulation stability and safety (U.S. Food and Drug Administration [FDA], 2023).

Fig. 4 East African *Ocimum* species' essential oils potential use in cosmetics

3.4.4.1 *Ocimum basilicum* Essential Oils

The essential oils of the species *O. basilicum* are commonly characterized by high levels of linalool, eugenol and eucalyptol, along with other monoterpenoids and phenylpropanoids. These constituents impart antioxidant, antimicrobial, and anti-inflammatory activities, which are responsible for the oil's bioactivity (El-Soud *et al.,* 2015). Ultimately, these properties support its use in formulations aimed at inhibiting the growth of skin-associated microorganisms, reducing inflammation and protecting the skin against oxidative stress. Such functional properties make *O. basilicum* oil suitable for products targeting oily, acne-susceptible or stressed skin. In this study, notable chemical variations were observed in East African *O. basilicum* essential oils, with linalool being the most dominant chemotype (Table 2). These findings were consistent with other studies carried out in Cameroon, Guinea, Egypt, Mali, Turkey and Brazil that reported a linalool chemotype (Pandey *et al.,* 2014). In contrast, chemotypes of *O. basilicum* reported elsewhere included estragole-linalool, (E)-β-farnesene-estragole and methyl cinnamate in Egypt (Qasem *et al.,* 2023), estragole-linalool in Nepal (Paudel *et al.*, 2025), eugenol-linalool in Cameroon (Nganou *et al.*, 2020), methyl chavicol in Morocco and Nigeria (Kasali *et al.*, 2005), and α-terpineol in Burkina Faso (Bayala *et al.,* 2014).

East African *O. basilicum* exhibited strong chemotypic diversity that directly influenced its aroma family and its potential use in cosmetics (Table 2). The accession from Kinshasa (DRC) was characterized by an estragole-linalool chemotype (Tshilanda *et al.,* 2016), producing a warm, sweet, spicy-floral aroma with gentle woody and herbal undertones (Spence, 2024; Sell, 2019) characteristic of a warm sweet spicy-floral aroma family. The oil is suited for sensitive skin formulations (Guzmán & Lucia, 2021; Paudel *et al.,* 2025). In Nepal, estragole-linalool rich *O. basilicum* essential oil successfully utilized together with *O. majorana* and *O. tenuiflorum* to develop a highly potent skincare cream formulation (Paudel *et al.,* 2025). Ethiopian accessions showed varying profiles with bisabolene-rich Genet 01 WOL genotype (Abdo *et al.,* 2021), giving a warm, woody aroma with sweet anise-herbal nuances, consistent with a woody-herbal scent family which is appropriate for calming and restorative body formulations (Kumari & Kumar, 2022; Butnariu, 2021). On the other hand, (E)-methyl cinnamate-linalool chemotype of Genet 06 WON emitted a warm, sweet, floral-spicy scent with balsamic hints (Spence, 2024), consistent with sweet floral-balsamic family valued in perfumes, deodorants and aromatherapeutic formulations (Shai *et al.,* 2009; Khatib, 2024).

Tanzanian essential oil from Mbeya displayed E-myroxide chemotype (Runyoro *et al.*, 2010), yielding a woody-resinous, softly spicy profile characteristic of woody-resinous aroma family (Van Opstaele *et al.,* 2013). In contrast, the oil from Rungwe shows an eucalyptol-dominated chemotype (Runyoro *et al.*, 2010), giving a fresh, herbal, slightly minty aroma aligning with the herbal-camphoraceous family (Kumari & Kumar, 2022; Zviely & Li, 2013). The two Tanzanian essential oils are suitable for perfumes, skincare and haircare formulations (Sarkic & Stappen, 2018). In Kenya, the camphor-linalool chemotypes from Yatta (Dambolena *et al.*, 2010) yielded moderate camphoraceous-floral scents with herbal and woody nuances (Kumari & Kumar, 2022; Chen *et al.*, 2013) placing them within the camphoraceous-floral aroma family. The oil is suitable for insect repellents, skincare, haircare and body relaxing formulations (Shai *et al.*, 2009; Khatib, 2024).

The geranial-neral chemotype from Kariti (Dambolena *et al.,* 2010), was rich in citral and produced a strong lemony-citrus aroma with sweet rosy and floral hints, aligning with the citrus-lemony family (Kumari & Kumar, 2022; Sharmeen *et al.*, 2021), supporting its use in perfumes, body mists, and fragranced creams (Sarkic & Stappen, 2018). In contrast, essential oils from Sagana were nearly-pure linalool chemotypes (Dambolena *et al.,* 2010), delivering soft, sweet-floral and fresh-citrus notes (Sell, 2019; Sharmeen *et al.*, 2021), consistent with fresh-floral aroma family. These oils are ideal for perfumes, deodorants and skincare formulations where mildness and broad consumer acceptance are desirable (Paudel *et al.*, 2025; Juergens, 2014). Collectively, these findings highlight East African *O. basilicum* as a highly versatile cosmetic ingredient whose chemotypes determine aroma identity and optimal applications.

3.4.4.2 Ocimum kilimandscharicum Essential Oils

Ocimum kilimandscharicum commonly known as the African blue basil or Camphor basil is native to East Africa and widely recognized for its distinctive camphor-rich essential oil which contributes to its strong camphoraceous aroma and diverse bioactivities (Ayoubi *et al.*, 2023). In this study, camphor chemotype dominated the essential oils from Kenya and Tanzania while eucalyptol chemotype was reported in Rwanda (Table 2). Previous studies reported camphor and methyl eugenol chemotypes in Bangladesh (Pandey *et al.,* 2014), and Nigeria (Lawal *et al*., 2014), respectively. The cosmetic potential of these essential oils is primarily driven by the bioactivities of their dominant compounds such as camphor, terpinen-4-ol, eucalyptol, camphene and limonene (Juergens, 2014; Tran *et al*., 2015; de Cássia *et al.*, 2014). The intensity of camphoraceous aroma varied across geographical locations, based on camphor content ranging from mild in Kirinyaga and Nyeri, moderate in Kasarani and Kakamega, strong in Trans-Nzoia and Mbeya, to highly intense in Kibungo and Naivasha

(Table 2). In Kenya, essential oils from Nyeri and Kirinyaga exhibited mild camphor chemotypes balanced by eucalyptol, geraniol, linalool, limonene and sesquiterpenes (Ngari *et al.,* 2019). This combination of compounds, yields mild camphoraceous, minty aromas with citrus, floral, and rosy hints (Sharmeen *et al.*, 2021; Chen *et al.*, 2013). The scents are consistent with a fresh, herbal-camphoraceous aroma family which is ideal for skin cleansing formulations (Khatib, 2024; Duda-Madej *et al.*, 2024; Fajdek-Bieda *et al.*, 2025). Essential oils from Kasarani (Mathu, 2015), and Kakamega (Ochola *et al.*, 2022), were characterized by moderate camphor chemotypes which were rich in limonene, terpinen-4-ol, camphene and linalool. This blend of compounds yields cool camphoraceous aromas with citrusy highlights and gentle floral hints (Sharmeen *et al.,* 2021; Chen *et al.,* 2013), supporting their use in insect-repellent sprays, footcare and body relaxing formulations (Ochola *et al.*, 2022; Opiyo, 2022).

Camphor intense chemotype was reported in Naivasha (Kweka *et al.,* 2009), and Trans-Nzoia (Mathu, 2015). The essential oils were characterized by high camphor and camphene contents producing strong, sharp camphoraceous aromas with herbal, fruity-floral, and spicy-woody undertones (Sharmeen *et al.*, 2021; Chen *et al.*, 2013). These oils are best suited for body relaxing formulations such as muscle rubs and liniments (Ligare, 2010). On the other hand, essential oil from Rwanda was characterized by eucalyptol chemotype which blended with limonene and pinene isomers (Ntezurubanza *et al.,* 1984) to produce an intense camphoraceous, citrus-piney scent (Sell, 2019; Sharmeen *et al.*, 2021). The oil is suitable for medicated topical formulations (Ligare, 2010). The essential oil from Mbeya in Tanzania displayed a camphor chemotype (Runyoro *et al.*, 2010), where combination with eucalyptol yields a strong cool camphoraceous aroma with citrus-herbal nuances (Sharmeen *et al.*, 2021; Chen *et al.,* 2013). This oil is favorable for insect repellent skincare, footcare and body relaxing formulations (Ochola *et al.*, 2022; Opiyo, 2022).

Collectively, camphor and eucalyptol dominance across *O. kilimandscharicum* chemotypes places the essential oils within the camphoraceous/cooling aroma family which is best suited for protective, cleansing, cooling and medicinal applications rather than perfumes. In Kenya, a commercial formulation, Naturub™ balm, was made using camphor-rich *O. kilimandscharicum* essential oil and is registered by the Pharmacy and Poisons Board of Kenya (Ligare, 2010). This balm is used to relieve colds, chest congestion, muscle pain, and insect bites. However, camphor can cause skin irritation when used at concentrations exceeding 1% in topical preparations and therefore should be used according to Food and Drug Administration code (U.S. Food and Drug Administration [FDA], 2023).

3.4.4.3 *Ocimum gratissimum* Essential Oils

Ocimum gratissimum essential oil, mostly documented to contain chemotypes rich in eugenol and thymol, has attracted interest as a natural cosmetic ingredient due to its biological and fragrance modifying properties (Pandey *et al.*, 2014; Guzmán & Lucia, 2021; Dharsono *et al.*, 2022). In East Africa, the species was reported to exhibit notable chemotypic diversity characterized by eugenol and eugenol-ocimene chemotypes (Table 2). Globally, a total of 30 chemotypes of *O. gratissimum* species has been reported in various countries (Gurav *et al.*, 2022). In Ivory Coast, thymol, thymol-*p*-cymene and thymol-γ-terpinene chemotypes were reported (Coulibaly *et al.,* 2023; Konan N'dri Séraphin *et al.*, 2022). On the other hand, thymol, (Z)-β-ocimene and eugenol-eucalyptol chemotypes were documented in Turkey, Thailand and Brazil, respectively (Pandey *et al.*, 2014). In this study, eugenol chemotype was reported in essential oils from Meru, Mombasa (Matasyoh *et al.*, 2008), Machakos (Muinde, 2015), Yatta, and Sagana in Kenya (Dambolena *et al*., 2010), Muhimbili in Tanzania (Runyoro, 1998), and Makerere in Uganda (Ocheng *et al.,* 2015) (Table 2). These oils also contained varying concentrations of methyl eugenol, sesquiterpenoids, and monoterpenoids which contribute to warm, spicy, clove-like aromas with sweet, woody, floral, or fruity nuances (Spence, 2024; Sharmeen *et al.,* 2021; Zviely & Li, 2013), aligning with spicy-woody/clove-like aroma family. The oils are best suited for perfumes as well as skincare, oralcare and haircare formulations where antimicrobial, antioxidant, and warm sensations are desirable (Khatib, 2024; Sarkic & Stappen, 2018).

In contrast, essential oils from Kakamega (Ywaya *et al*., 2020) and Kitui (Muinde, 2015) exhibit Z-(β)-ocimene-eugenol chemotype with varying concentrations of camphor, linalool, or bisabolenes (Table 2). These oils produce fresh floral-spicy aromas with woody, balsamic, fruity, or slightly camphoraceous undertones, consistent with spicy-floral or spicy-balsamic aroma families (Sharmeen *et al*., 2021; Zviely & Li, 2013). The aromatic balance expands the applications of these oils beyond medicated skincare formulations to include perfumes, body relaxing, antiaging lotions and haircare products (Guzmán & Lucia, 2021; Sarkic & Stappen, 2018). On the other hand, *O. gratissimum* leaf essential oil from Machakos exhibited (E)-*β*-caryophyllene chemotype with blends of α-copaene, methyl isoeugenol and (*Z*)-*β*-ocimene (Muinde, 2015). The chemical profile contributes to warm, spicy, scent with resinous sweet clove-like nuances and woody hints (Spence, 2024) which falls within warm-woody aroma family. This oil is suitable for perfumes, skincare and haircare formulations (Khatib, 2024). However, these oils should be used at controlled concentrations in cosmetic formulations due to eugenol's potential to cause skin irritation (The International Fragrance Association [IFRA], 2020). Collectively, the balance between the aromatic and bioactivities of *O. gratissimum* essential oils underscores their versatility as a functional and fragrance component in cosmetic formulations.

3.4.4.4 *Ocimum americanum* Essential Oils

The essential oils from *O. americanum* were characterized by the presence of monoterpenoids such as linalool and eucalyptol. These compounds have been documented to enhance the potential use of the oil as a component of multifunctional cosmetic formulation due to its bioactivity (Pandey *et al.*, 2014; Matasyoh *et al*., 2006; Guzmán & Lucia, 2021). In this study, the essential oil profiles of *O. americanum* from Kenya displayed a marked chemical diversity featuring α-pinene-umbellulone, terpinen-4-ol, eucalyptol, eucalyptol-linalool, and linalool-eucalyptol chemotypes (Table 2). This finding is supported by previous studies where *Ocimum* species were reported to exhibit pronounced intraspecific chemical variability attributed to genetic and environmental factors (Vani *et al*., 2009; Gurav *et al.*, 2022). Elsewhere, eucalyptol chemotype was reported in Burkina Faso (Bayala *et al*., 2014; Coulibaly *et al.,* 2023), whereas a methyl eugenol chemotype was documented in Senegal and Gambia (Tine *et al.*, 2024). In Nepal, camphor chemotype was dominant (Paudel *et al.*, 2025), while geraniol-neral and camphor chemotypes characterized the essential oils in Bangladesh (Pandey *et al.,* 2014).

The essential oil from Homabay exhibited an α-pinene-umbellulone chemotype (Bett *et al.*, 2022), which combines pinene, umbellulone, limonene, and cadinene isomers. This composition produces a bright minty-camphoraceous scent with citrusy and balsamic nuances (Sell, 2019), aligning with fresh camphoraceous aroma family. This chemical and aromatic profile supports its use in skincare and body relaxing formulations where cooling and antimicrobial effects are valuable (Guzmán & Lucia, 2021). In contrast, the essential oil from Rachuonyo–Suba presented a terpinen-4-

ol chemotype with high eucalyptol levels (Matasyoh *et al.*, 2006). The oil produces a fresh herbal-floral scent with warm woody undertones (Kumari & Kumar, 2022), characteristic of fresh-herbal aroma family suitable for medicated skincare and oralcare formulations (Khatib, 2024; Sharmeen *et al.,* 2021).

Essential oils from other parts of Kenya such as Machakos (Mathu, 2015; Muinde, 2015), Tharaka Nithi (Muthengi *et al*., 2025), and Kitui (Muinde, 2015), were dominated by eucalyptol or eucalyptol-linalool chemotypes with varying concentrations of α-terpineol, pinene isomers and sesquiterpenes. The oils produce fresh camphoraceous, floral scents with herbal highlights and woody or resinous undertones, which aligns with fresh-herbal, camphoraceous and soft floral aroma families (Kumari & Kumar, 2022; Sharmeen *et al*., 2021). The balanced aroma coupled with functional properties positions the essential oils as ideal ingredients for light perfumes, skincare and haircare formulations (Guzmán & Lucia, 2021). Overall, variation in the dominance of umbellulone, terpinen-4-ol, eucalyptol, and linalool across *O. americanum* chemotypes controls aroma expression and aligns the essential oils towards cleansing, cooling, soothing and antimicrobial formulations rather than heavy perfumery.

3.4.4.5 Ocimum suave Essential Oils

This species has been reported to produce essential oils that exhibit substantial chemical variability, typically dominated by monoterpenoids such as eucalyptol, camphor, linalool, and terpinen-4-ol, reflecting both genetic diversity and environmental influences (Pandey *et al*., 2014; Runyoro *et al*., 2010; Dharsono *et al*., 2022). The species *O. suave* was found to exhibit chemotypic diversity across East Africa comprising of eugenol (Runyoro, 1998), methyl eugenol, germacrene-D (Runyoro *et al*., 2010), and bisabolene chemotypes (Muthengi *et al*., 2025), (Table 2). In Tanzania, essential oils from Mbeya and Rungwe exhibited eugenol and methyl eugenol chemotypes, respectively (Runyoro *et al*., 2010). The chemical composition profiles of these oils would produce warm, spicy, clove-like scents with fresh green, woody, or soft floral nuances (Spence, 2024; Sharmeen *et al.,* 2021; Zviely & Li, 2013), consistent with spicy-herbal and sweet spicy-floral aroma families. These aromatic and functional profiles support their use in perfumes, medicated skincare and haircare formulations where antimicrobial and deodorizing properties are required (Sharmeen *et al*., 2021; Zviely & Li, 2013).

The essential oil from Kimbiji (Tanzania) displayed a germacrene-D chemotype with varying concentrations of ocimene isomers (Runyoro, 1998), producing woody-balsamic scent with fresh green, resinous undertones (Sharmeen *et al.,* 2021; Zviely & Li, 2013), aligning with a woody-resinous aroma family. This oil is suitable for perfumes, anti-aging skincare, haircare and body relaxing formulations where depth and fixative properties are required (Sarkic & Stappen, 2018). In contrast, essential oil from Meru (Kenya) was characterized by a bisabolene chemotype (Muthengi *et al.*, 2025), producing a fresh citrusy scent with warm woody and spicy undertones, consistent with fresh citrus-spicy aroma family. The essential oil is ideal for perfumes, deodorants, skincare and haircare formulations (Sarkic & Stappen, 2018; Kumari & Kumar, 2022; Sharmeen *et al.,* 2021). Overall, the blend of eugenol, methyl eugenol and sesquiterpenes provides functional versatility of *O. suave* essential oils as cosmetic ingredients leaning towards perfumery, skincare and haircare applications.

3.4.4.6 Ocimum lamiifolium Essential Oils

From literature, *O. lamiifolium* essential oils are characterized by chemotypic variability, with monoterpenoids such as eucalyptol, camphor, linalool, and terpinen-4-ol, reported as the dominant constituents (Sahalie *et al.*, 2018). Similarly, in East Africa, the *O. lamiifolium* species displayed diverse chemotypes (Table 2). The essential oils from Nyandarua and Nakuru (Kenya) exhibited an α-phellandrene chemotypes combined with (E)-2-octenyl acetate, germacrene-A and ocimene (Shai *et al.,* 2009) giving fresh, green-citrusy scents with fruity-sweet top notes and warm, woody-spicy undertones (Porat *et al*., 2016; Butnariu, 2021). These scent profiles place them within fresh citrus-woody aroma family which is suitable for perfumes, soothing skincare and haircare formulations (Shai *et al.*, 2009; Lodén & Maibach, 2005; Thangaleela *et al.*, 2022). Essential oils from Ethiopia showed linalool-octenyl propionate chemotype with a blend of geraniol, verbenol, camphene and γ-cadinene (Sahalie *et al*., 2018). The oil gives floral, citrus scent with fruity, sweet and herbal-woody undertones (Guzmán & Lucia, 2021; Sharmeen *et al.*, 2021), characteristic of fresh floral-citrus aroma family. On the other hand, essential oil from Tanzania exhibited bornyl acetate chemotype with a blend of p-cymene, camphene and pinene isomers (Runyoro *et al.*, 2010. The oil exhibits a fresh, camphoraceous-pine scent with citrusy and herbal notes aligned with herbal, camphoraceous aroma family. The aromatic and functional profiles positions essential oils from Ethiopia and Tanzania as potential ingredients in perfumes, skincare and haircare formulations (Shai *et al.,* 2009; Guzmán & Lucia, 2021; Damasceno *et al.*, 2025). Overall, chemotypic variation in *O. lamiifolium* underscores its potential application in functional and luxury cosmetics.

3.4.4.7 Ocimum kenyense Essential Oils

Essential oils of *O. kenyense* have been described as chemically heterogeneous, with profiles typically dominated by estragole-eucalyptol and eucalyptol-selinene across Kenyan populations (Table 2). Essential oils from Nyeri and Laikipia (Kenya) were characterized by estragole-eucalyptol chemotypes, with varying concentrations of β-bisabolene, chavicol, α-humulene and β-myrcene (Shai *et al.,* 2009), producing fresh, sweet herbal-anise scents with soft spicy, camphoraceous, and woody undertones, characteristic of the herbal, anise-woody aroma family (Spence, 2024; Kumari & Kumar, 2022). These profiles are particularly suited for perfumes, deodorants, footcare, skincare and body relaxing formulations where mild sweetness, soothing, freshness, and soft spiciness sensations are required (Khatib, 2024; Guzmán & Lucia, 2021; Bolouri *et al*., 2022). Essential oil from Nairobi displayed eucalyptol-selinene chemotype (Bekele & Hassanali, 2001). The blend of eucalyptol, β-selinene, estragole and iso-eugenol produces a fresh, cooling herbal scent with sweet, spicy highlights and woody undertones (Spence, 2024; Kumari & Kumar, 2022), consistent with fresh herbal-woody aroma family. This profile supports applications in deodorants and soothing skincare formulations where freshness and gentle herbal sensation are desired (Khatib, 2024; Guzmán & Lucia, 2021; Sharmeen *et al.*, 2021). Overall, the chemotypic variation in *O. kenyense* influences its aroma profiles and positions it as a versatile functional and fragrant ingredient in cosmetic formulations.

3.4.4.8 Ocimum urticifolium Essential Oils

Similar to the other species of the genus *Ocimum*, essential oils obtained from *O. urticifolium* have been reported to exhibit chemically diverse profiles, commonly dominated by monoterpenoids (Alemayehu *et al.*, 2016; Pandey *et al.*, 2014). This species displayed clear chemotypic variations across East Africa (Table 2). The Ethiopian accession from Mekelle represented an α-pinene-eugenol chemotype with varying concentrations of sesquiterpenoid constituents (Alemayehu *et al.*, 2016). This composition produces a fresh, piney, woody scent with warm spicy and balsamic undertones (Kumari & Kumar, 2022; Sharmeen *et al.*, 2021). The profile is characteristic of a fresh woody-spicy aroma family, making it ideal for perfumes, haircare, cleansing and restorative skincare formulations where freshness and revitalizing effects are desired (Khatib, 2024; Sharmeen *et al*., 2021). In contrast, essential oils from Rwanda exhibited methyl isoeugenol and ocimene-eugenol chemotypes (Janssen *et al*., 1989), producing sweet, spicy clove-like scents with bright green and citrus nuances (Spence, 2024; Zviely & Li, 2013), aligning with the sweet spicy-floral aroma family. These softer yet pronounced aromatic profiles are suitable for perfumes, haircare, soothing skincare and body relaxing formulations where scent diffusion, sweetness and warm sensations are required (Shai *et al*., 2009; Fajdek-Bieda *et al*., 2025; Bolouri *et al*., 2022). Collectively, chemotypic variation underscores versatility of *O. urticifolium* across cleansing and fragrance based cosmetic formulations.

3.4.4.9 *Ocimum canum* Essential Oils

Consistent with chemodiversity reported across the genus *Ocimum*, the essential oil composition of *O. canum* shows marked variability (Ngassoum *et al*., 2004; Tonzibo *et al*., 2008; Pandey *et al*., 2014). *O. canum* from Tanzania exhibited a distinct chemical variation comprising of ocimenyl oxide and eucalyptol geranyl chemotypes (Table 2). In contrast, eucalyptol and geraniol-linalool chemotypes of *O. canum* were reported in Ivory Coast (Tonzibo *et al*., 2008), and Cameroon (Ngassoum *et al*., 2004), respectively. In addition, Thailand and Turkey essential oils showed neral-geranial and linalool chemotypes, respectively (Pandey *et al.,* 2014). Essential oil from Muhimbili was dominated by an ocimenyl oxide chemotype with varying concentrations of β-pinene, terpineol, myrcene and caryophyllene (Runyoro, 1998). The oil produces a fresh green- herbaceous aroma with piney, woody, and soft floral undertones (Sharmeen *et al*., 2021; Zviely & Li, 2013), characteristic of a fresh herbal-green aroma family. It is suitable for perfumes, deodorants, cleansing skincare and haircare formulations where clean and fresh sensations are needed (Guzmán & Lucia, 2021; Bolouri *et al*., 2022). In contrast, essential oil from Kimara exhibited eucalyptol-geranyl acetate chemotype with varying concentrations of linalool, geraniol, neranial and neral acetate (Runyoro, 1998). The oil yields a fresh camphoraceous, citrus aroma with floral-sweet and fruity undertones (Kumari & Kumar, 2022; Sharmeen *et al*., 2021), aligning with fresh citrus, camphoraceous aroma family. This aromatic profile supports its use in deodorants, foot-care products, skincare and haircare formulations where both clean, fresh and mild soothing effects are required (Fajdek-Bieda *et al*., 2025; Bolouri *et al*., 2022).

3.4.4.10 *Ocimum sanctum* Essential Oils

The essential oil of *O. sanctum* has attracted increased scientific attention due to its consistently high proportion of phenylpropanoids and monoterpenoids across various populations globally (Pandey *et al*., 2014; Dharsono *et al*., 2022; Gurav *et al*., 2022). Studies in East Africa have reported consistency in bisabolene dominated chemotype in Ethiopia with varying concentrations of eucalyptol, estragole and eugenol (Table 2). Previous studies on this species carried out in Bangladesh, India and Thailand revealed eugenol, methyl eugenol and methyl eugenol-caryophyllene chemotypes, respectively (Pandey *et al*., 2014). This marks a huge contrast which could be attributed to variations in geographical and climatic factors in Asian and African continents. The essential oils from Bishoftu and Debre Berhan in Ethiopia yields warm, sweet-woody scents with fresh camphoraceous and soft spicy-clove like undertones (Kumari & Kumar, 2022; Sharmeen *et al.,* 2021), which fall within the woody-sweet balsamic aroma family. Due to their depth and fixative properties, these oils are best suited for protective, calming, restorative and sensitive-skincare products as well as perfumes, deodorants and footcare formulations (Guzmán & Lucia, 2021; Reddy *et al*., 2025). Overall these aromatic and functional properties positions *O. sanctum* essential oils for versatile applications in cosmetic formulations where fresh, clean, warm and soothing sensations are desired.

4.0 Conclusion

This review explored *Ocimum* species found in East Africa as potential sources of natural fragrance for cosmetic industry. Majority of *Ocimum* essential oils were dominated by monoterpenoids followed by sesquiterpenoids and phenylpropanoids which produce a wide of attractive aromas. Several aroma families characterized the scent profiles of the essential oils with camphoraceous/cooling the most common. Apart from from the reported ability to impart pleasant aromas to formulations, these oils also exhibit biological activity supporting their use as multifunctional cosmetic ingredients. These oils exhibit versatility and potential for diversified applications in skincare, perfumes, deodorants, haircare, footcare, oralcare, insect repellents, and body-relaxing formulations. To realize full potential of the essential oils as fragrance ingredients, standardized cultivation and extraction practices are important in ensuring consistency in chemotypes and reliable yields. Equally important is the assessment of safety, stability and efficacy of *Ocimum* essential oils' based cosmetic formulations. As global demand for natural fragrance ingredients increases, there is need to promote sustainable utilization of indigenous botanical resources while supporting bio-based economy. Overall, the chemical and aromatic diversity of the *Ocimum* species essential oils found in East Africa positions them as potential fragrance sources aligning with the growing consumer demand for natural ingredients in cosmetics.

Acknowledgements: We would like to acknowledge the support of Karatina University in making this work possible.

6.0 References

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Compliance with Ethical Standards Declarations

The authors declare that they have no conflict of interest.

Data availability

The publisher has the right to make the data public

Consent for publication

Not Applicable

Competing interests

The authors declared no conflict of interest.

Funding

The authors declared no source of funding.

Authors' Contribution

Both authors contributed significantly in all aspects of the work