COLEAD

SECTOR STUDY: CITRUS OIL AND PEEL

3. Citrus oil and peel

Funded by the European Union

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1. What are citrus oil and peel

Citrus oil and peel are value added products that are typically recovered from juice production. Citrus oil is pressed from the outer skin (flavedo) of the fruit, which is rich in oil sacks. The oil contains concentrated colours, flavours and aromas that are highly desirable to companies that manufacture food, beverages, cosmetics and household care products. Under the outer skin (flavedo) is an inner layer called the albedo (rag) that is rich in fibre and pectin and can also be processed into valuable products for the food industry.

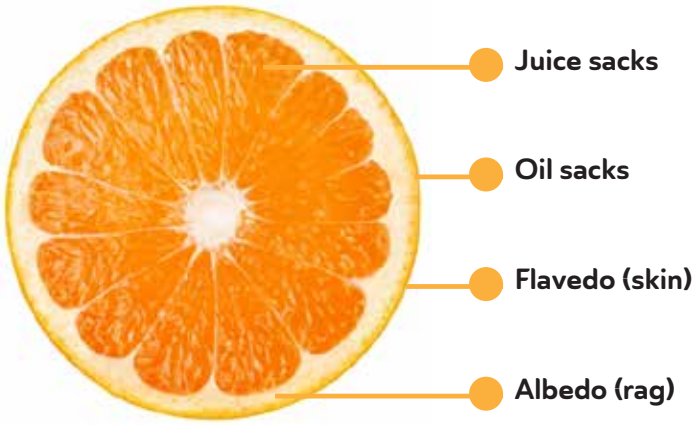


Figure 1: Parts of an orange

Oil can be pressed from peel, and peel can be ground into powder for further processing. Citrus peel can also be sold along with other solid residue from juice production (pomace).

Citrus oil is known for its antimicrobial, antioxidant and anti-inflammatory properties, making it valuable in food preservation, cosmetics and pharmaceuticals. Beyond oil and peel, the citrus processing industry also produces other valuable by-products, such as pectin from citrus peel that is widely used as a gelling agent in food products like jams and jellies.

Processed citrus products have a wide range of applications across several industries, making them highly sought-after ingredients.

Food and Beverage Industry

Cosmetics and Personal Care

Cleaning

Aromatherapy

Pharmaceuticals and Supplements

Animal Feed & Compost

Food and beverage industry

Citrus oil and peel are extensively used to enhance flavours, colours and aromas. The oil, especially those from oranges and lemons, are key flavour ingredients in soft drinks, baked goods, sweets and desserts. Citrus peel, often used as a zest, add texture and flavour to culinary dishes and beverages. A clouding agent used in some beverages is made from the albedo, amongst a wide variety of products that can be created using the oil and peel.

Cosmetics and personal care

Citrus oil is prized for its fresh scent and benefits to the skin. It is commonly found in perfumes, lotions, soaps and shampoos. Lemon oil and lime oil are also used for their astringent and antiseptic qualities, being popular in formulations designed to cleanse and tone the skin.

Cleaning products

Citrus oil is used in many household cleaning products due to its natural degreasing qualities and pleasant fragrance. Lemon oil in particular, is a common ingredient in surface cleaners, air fresheners, and dishwashing liquids. The antibacterial properties of citrus oil also make it effective in disinfecting and deodorising spaces.

Aromatherapy

In aromatherapy, citrus oil is used for uplifting and energising effects. Oil from orange, grapefruit and bergamot (used specifically for its essential oil – its fruit is not edible) are popular for use in diffusers and massage oils, with citrus scents often associated with feelings of freshness and rejuvenation.

Pharmaceuticals and supplements

Citrus oil and peel are used in the pharmaceutical and nutraceutical (supplement) industries. The high content of antioxidants, vitamins and bioactive compounds make the oil valuable in the formulation of dietary supplements and natural remedies, included for their health benefits, such as supporting the immune system and improving cardiovascular health.

Animal feed and compost

The residues from orange juice processing can be used as an ingredient in livestock feed rations, and in compost. The albedo which is rich in dietary fibre, is also used as a filler in pet food.

2. Demand

2.1. Market overview

In 2023, more than 165 thousand tonnes of citrus oil and peel, worth US$2.5 billion, was traded, a 1% annual increase on the 150,000 tonnes traded in 2013. This market size is expected to continue to grow in the coming years[1]. Of all global imports, 60% is imported by the European Union (EU), followed by North America.

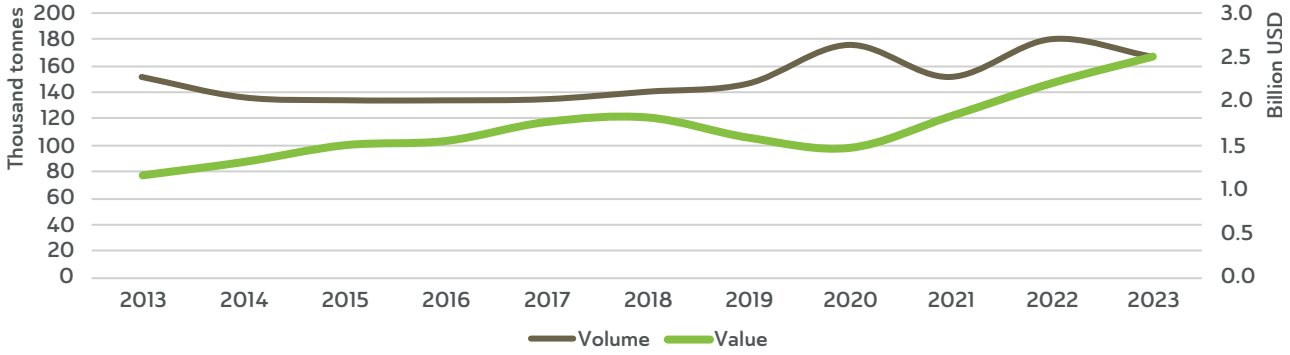


Figure 2: Evolution of global trade of citrus oil and peel between 2013 and 2023 in volume and value. Source: COLEAD based on CEPII BACI, Eurostat, UK Trade Info and IFPRI.

2.2. Trade by region

The European Union and United Kingdom

The EU27+UK is the largest importing region of citrus oil and peel, accounting for more than half of the global imports. Germany, the Netherlands, Italy, and the United Kingdom are the four largest importers. Germany's market for these products has been steadily increasing, and Italy's experienced rapid growth since 2020. Figure 3 shows the imports of France, Germany and the Netherlands excluding their exports of citrus oil and peel to other EU countries, to have a better idea of the size of the markets without looking at intra-EU trade. Italy, however, exports more citrus oil and peel than it imports, because a lot of the exports actually come from its own production, rather than a re-export.

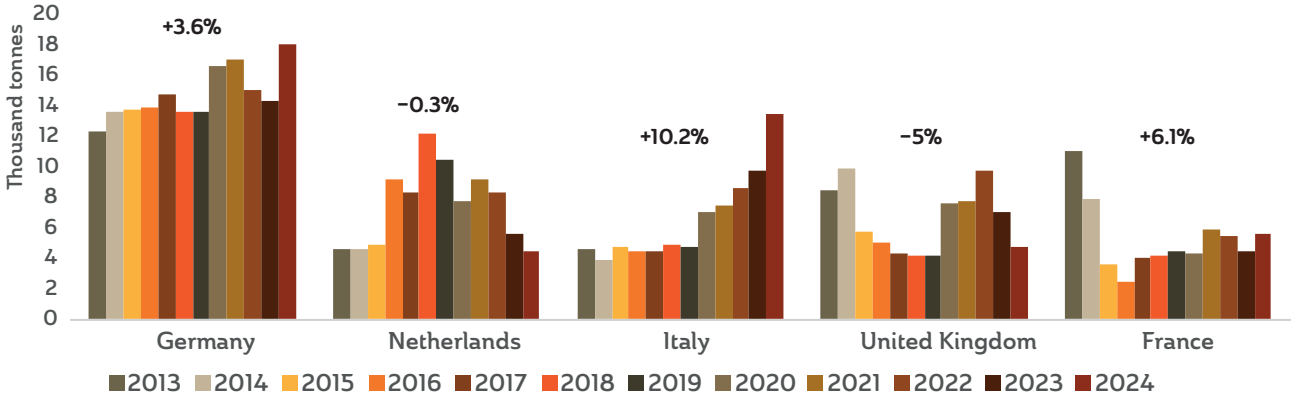


Figure 3: Top five main destination markets for oils and peels in the EU27+UK between 2013 and 2024. Source: COLEAD based on Eurostat and UK Trade Info.

1 Market Research Future (2025) Citrus essential oil market research. https://www.marketresearchfuture.com/reports/citrus-essential-oil-market-24383

USA

The USA is the second largest importer of citrus oil and peel globally, despite being a large producer of citrus fruit. Imports have grown in both volumes and values over the past 12 years (+2.7% CAGR), albeit with fluctuations. Since 2020, where supply was limited in Brazil and the USA, the value of imports into the USA increased sharply.

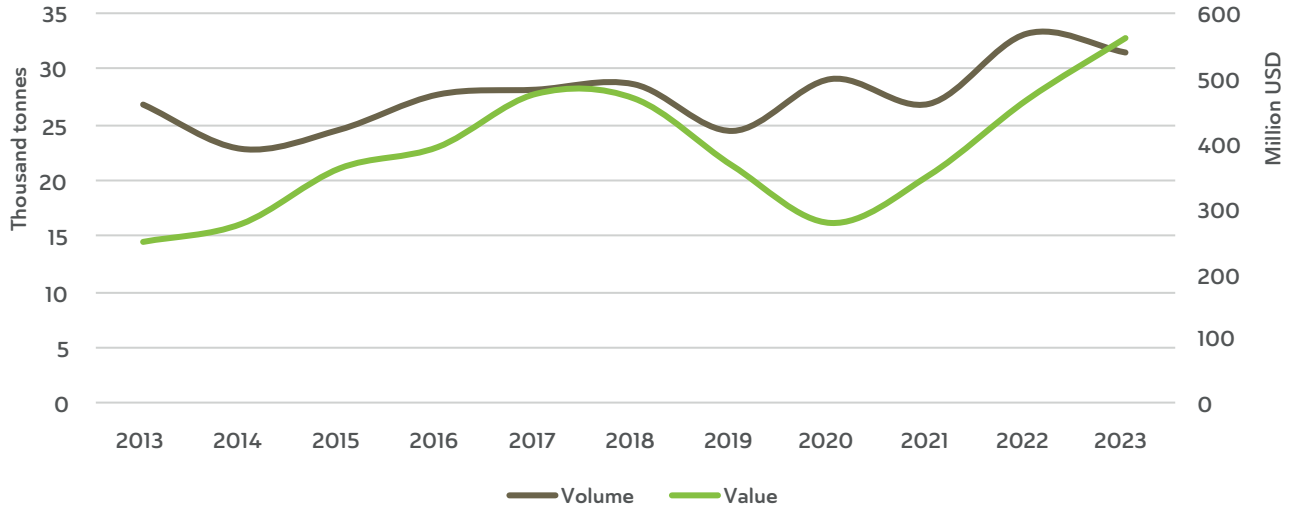


Figure 4: Imports of citrus oil and peel in the USA. Source: COLEAD based on CEPII BACI, Eurostat, UK Trade Info and IFPRI.

Asia

Asian imports of citrus oil and peel are considerably smaller than imports to other regions. Japan, for example, the biggest importer of citrus oil and peel in Asia in 2023, imported 5,500 tonnes, compared with Germany's imports of around 20,000 tonnes in the same year. Japan, China, Singapore and India are the largest importers in the region by volume, but together they import only 9% of global imports.

Over the past 10 years, imports to the region have slightly decreased (–3.4% annually in average), with variations between countries. China was the largest importer in 2013 but imports decreased thereafter (–4.8% annually), possibly due to increased domestic production, whereas there were slight increases in imports during the same period in Singapore and Indonesia. It is important to note that China is the largest producer of oranges globally, allowing this market to be largely self-sufficient, which explains the smaller imports opportunities in this market.

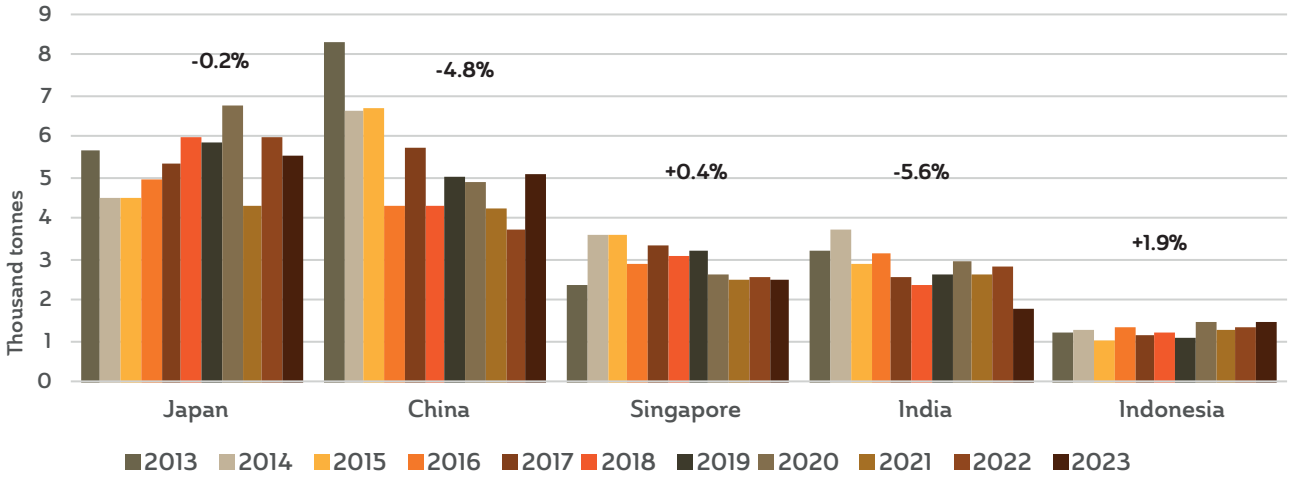


Figure 5: Imports of citrus oil and peel into Asia and Southeast Asia. *Source: COLEAD based on CEPII BACI, Eurostat, UK Trade Info and IFPRI.*

Trade in specific products

The citrus oil and peel market consists of various segments.

Table 1: Citrus peel market segmentation

	Product type	Fruit type	Form	End use
Citrus peel segmentation	Organic or conventional	Orange, lime lemon, grapefruit, mandarin, bergamot, others	¨ Peel pieces ¨ Powder ¨ Oil	¨ Food processing ¨ Beverage processing ¨ Food services ¨ Fertiliser ¨ Animal feed ¨ Home care ¨ Cosmetics and personal care ¨ Others (herbal medicine, pharmaceuticals, etc.)

Orange oil dominates the market with 62% of the global market share. Lemon oil and peel make up about 16%. Lemon and lime oil are used in the cosmetics and pharmaceutical industries for their antimicrobial and refreshing properties. Amongst all essential oils worldwide, citrus oil is the most popular by a very long way, at 1 million metric tonnes per year, 20 times more than the trade in the next most popular (mint oil).

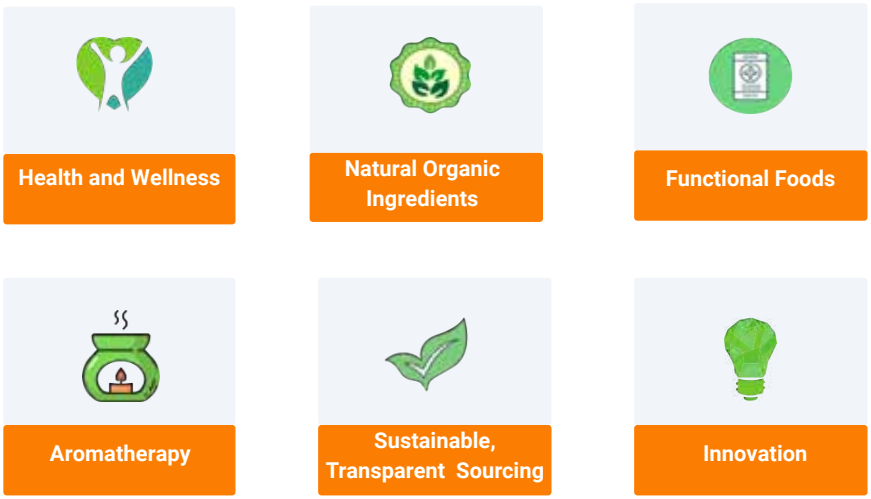
Table 2: Most popular essential oils – global trade by volume (tonnes), 2023. Source: https://www.cbi.eu/market-information/natural-food-additives/essential-oils-food/market-potential

Essential oil	Volume in tonnes
Citrus oil (peel)	1,000,000
Mint oil (leaves)	50,000
Clove oil (bud, leaves, stems)	30,000
Eucalyptus oil (leaves)	20,000

The large volumes of citrus oil also reflect their wide range of applications across multiple industries. Compared to other oil sectors, citrus oil has a distinct advantage due to its versatility and relatively low cost of production, with most (particularly orange oil) being by-products of the juice industry. This contrasts with other essential oils such as peppermint, which require the growing of dedicated crops and more intensive processing.

2.3. Market trends

There are key trends driving the growth of processed citrus peel products.



Health and wellness

The health and wellness movement is boosting demand for citrus oil, particularly in aromatherapy and alternative medicine. Citrus oil is valued for its therapeutic properties, such as their ability to lift mood, reduce stress, and support the immune system. This trend is expanding the market for citrus oil beyond traditional applications, into wellness and self-care products.

Natural, organic ingredients

There is a growing consumer preference for natural and organic products, which has positively impacted the processed citrus sector. Especially in Europe and North America, consumers are increasingly seeking products with natural ingredients, driving demand for citrus oil in food, beverages, cosmetics and personal care products. Consumers also prefer reading simple ingredients on product labels that are easy to understand and list few synthetic components. In personal care and cosmetics, citrus oil is becoming popular due to its revitalising and invigorating qualities, being integrated into hair care formulations and skincare products. This trend is in line with the growing preference for natural components in personal care, as people look for products that contribute to both their beauty and overall wellbeing.

The versatility of citrus oil in enhancing flavours and aromas is propelling their increased use in the food and beverage industry. From adding a zesty twist to beverages and baked goods to infusing savoury dishes with a burst of freshness, citrus oil is finding diverse applications. This trend follows changing consumer palates and offers food manufacturers a natural and concentrated flavouring solution. Orange oil and bergamot oil are used as foundational notes in fragrances or blended with other scents to create refreshing and uplifting aromas, though the popularity of citrus scents can fluctuate with trends, such as “botanical” or “floral” fragrances.

Functional foods and fragrances

Functional foods contain substances that have positive effects on health beyond basic nutrition (e.g. fortified food). Healthy foods such as fruit are considered functional foods as they provide a range of benefits such as lowering cholesterol or boosting the immune system. Citrus oil is increasingly used in functional beverages, dietary supplements and fortified foods, where

their properties enhance the health appeal of products. There has been a rapid increase in fragrance launches that advertise functional benefits such as alertness or sleep enhancement, as a result of including essential oil in the formulas.

Aromatherapy

The therapeutic properties of citrus oil, known for their uplifting and invigorating scents, are driving their integration into aromatherapy and wellness products. Orange oil and lemon oil are being used in essential oil blends, candles and diffusers, to promote a sense of wellbeing. This trend aligns with the growing interest in holistic health practices and the desire for natural alternatives to synthetic fragrances.

Sustainable sourcing and transparency

Sustainable sourcing is a major trend in Europe, with consumers more conscious of the social and environmental consequences of their purchases, and are increasingly interested in the origin of food and its ingredients. As a result, they expect suppliers to demonstrate greater corporate environmental and social responsibility and clear transparently in product labelling. Non-governmental organisations lead the push for companies to improve their practices and adopt sustainable sourcing. Initially, this focused on large-scale commodities to create a broader impact, but smaller manufacturers have also for many years been extending sustainable sourcing strategies to lower volume ingredients, such as essential oil.

Innovation

Innovation in product development is pushing the boundaries of the citrus oil market. Suppliers explore new citrus varieties, extraction techniques and formulations to meet the evolving demands of consumers. From concentrated oil for industrial use to unique blends for niche applications, there is a culture of continuous improvement and creativity. Figure 6 shows the large range of new products using essential oil launched in Europe in 2022. Of all new product launches from the top 30 food and drink companies, about 40% contain essential oil. Most of these will contain citrus oil, as by far the commonly used essential oil in the world.

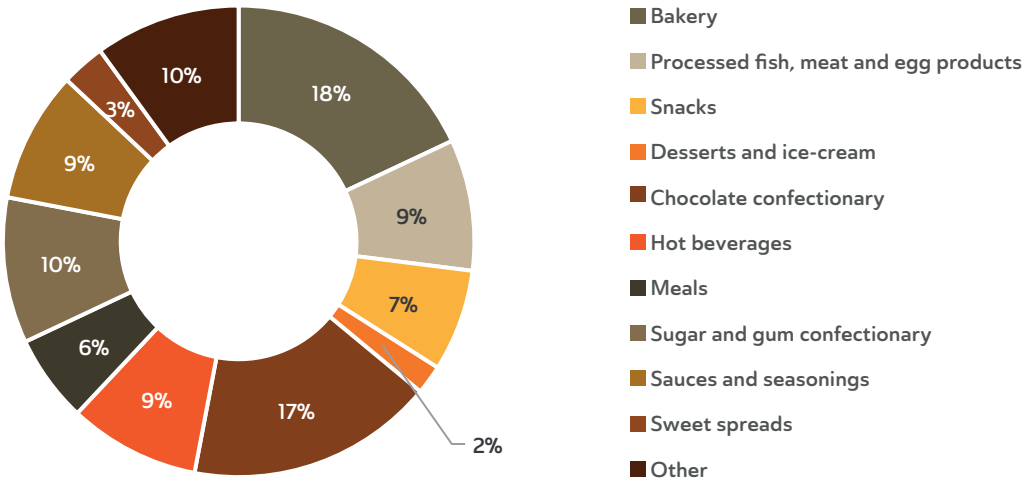


Figure 6: New essential oil-based food and drink products launched in Europe, by category, 2022. Source: Mintel (2022), as shown in: www.cbi.eu/market-information/natural-food-additives/essential-oils-food/market-potential

2.4. Market prices

Table 3: Prices of citrus oil, 2023. Sources: Importer interviews, The International Federation of Essential Oils and Aroma Trades (www.IFEAT.com), Ultra International BV (www.ultranl.com), Tradekey (www.tradekey.com), Go4 World Business (www.go4worldbusiness.com)

	Oil	Peel
Orange	US$3–15/kg (at the higher end due to the poor orange harvest in Brazil)	US$2–4/kg
Lemon	US$7–20/kg	US$2–5/kg
Grapefruit	US$25–55/kg	US$1–3/kg
Mandarin	US$50–150/kg (lower in China, the largest global producer of citrus fruit)	US$3–6/kg
Bergamot	US$165–400/kg	

Citrus oil also has two different price ranges depending on the end use, either for (1) mass market citrus oil, or (2) speciality citrus oil.

Mass market citrus oil

Oranges, lemons and grapefruit are pressed into juice at a large scale in supplying countries, and as oil is a by-product of juice production, the sheer volume of fruit being processed creates opportunities to produce large volumes of oil and peel.

This has two major positive knock-on effects. Firstly, prices do not rise too high, as large scale production allows companies to allocate fixed costs of oil and peel production over a larger volume. Oil produced by juice companies can lower their fixed cost per litre even further.

The difference in the scale of production of fresh oranges and juice, compared to lemon and grapefruit, creates further differences in prices of specific mass market citrus oil. Orange oil can be as cheap as US$3 per kg, where the starting price for grapefruit oil is $25 per kg.

Speciality oil

Mandarin and bergamot are speciality oils, which affects their availability and market price. Mandarin is typically sold as a fresh fruit, with only a small portion being used to produce juice. The processing ratio from fresh to oil is also considerably lower than oranges or lemons. The supply of mandarin oil and peel is thus lower, which drives up prices compared to orange and lemon oil. The smaller scale of mandarin oil and peel also means that the fixed costs per kilogram for producing these oils are higher. This is especially the case in specialised companies that might be manufacturing mandarin or bergamot oil as a stand-alone product. The full fixed costs must be carried on a smaller production volume.

Bergamot orange, which is grown exclusively for oil, is very expensive for similar reasons. The scale of production is far lower than for other citrus, as it is grown in a limited area, most around the Mediterranean. Secondly, they are typically processed by companies specialising in essential oil processing. As with mandarin oil, the lower supply and the higher fixed costs per unit all increase the market price. Bergamot oil can be three times the price of mandarin oil, and 25 times the price of orange oil.

Price volatility

The pricing of oil and peel are heavily influenced by supply factors. In an ordinary year, when there is sufficient supply of fresh fruit on the global market, volumes of oil rise and the price falls. However, with major producing countries experiencing supply challenges in recent years, there are often sharp changes in the price of oil. The case of Brazil's orange oil is taken as a case study. Brazil, the largest exporter of citrus oil and peel, due to its massive orange juice production, exported 36,000 tonnes of orange oil in 2020, which corresponded with the lowest price in five years, of US$4.5/kg (FOB). Exports declined in the years that followed, and prices rose (Figure 7).

Figure 7: Brazil orange oil exports between 2002 and 2023 in volume and evolution of price (US$/kg FOB). Source: COLEAD based on CEPII BACI, Eurostat, UK Trade Info and IFPRI, and IFEAT Orange report.

2.5. Buyer requirements

When purchasing citrus essential oil, buyers have specific requirements to ensure quality, safety, and sustainability. These can vary based on the market segment (cosmetics, food or aromatherapy), but there are common buyer demands.

Quality requirements

For essential oil

- Purity: Oil must be pure and free from contaminants or adulteration, and not mixed with synthetic chemicals or other oil unless specified.
- Chemical composition: Oil must meet specific chemical profile standards (e.g. limonene levels in orange oil), with results from accredited laboratories on gas chromatography and mass spectrometry tests.
- Organoleptic properties: Aroma, colour and clarity are important factors in the food and fragrance sectors.

For citrus peel

- Fresh peel: Must be free from blemishes, mould and signs of decay, and retain their natural colour, aroma, and texture.

- Dried peel: Must be clean, with no contaminants or foreign materials, with colour and aroma preserved, with no mould or degradation. Buyers expect a low moisture content, typically 8–12%, to prevent spoilage and ensure long shelf life.
- Peel powder: Must be finely ground and free from clumping or moisture, with a natural, vibrant colour and strong citrus scent. Should have minimal moisture content to avoid clumping and ensure a longer shelf life.

Consistency

The profile of citrus oil varies depending on fruit type, extraction method, and environmental conditions in which fruit was grown, such as soil type, climate and harvest time. Buyers expect consistent quality with every batch, meaning that variations in scent, chemical composition or purity must be minimal, that can be achieved by standardisation through blending oils from different harvests or regions.

Pesticide residues

Each citrus oil has a distinct chemical composition that defines its unique characteristics. However, a significant challenge in citrus oil production is pesticide residue. Citrus crops are commonly treated with pesticides both before and after harvest, and postharvest treatments in packhouses often exacerbate this issue, as pesticides can penetrate the oil glands in the skin of the fruit. As a result, every batch of citrus oil must be tested for pesticide residue, and the level determines the potential application of the oil. If the pesticide levels are low, oil can be sold for food consumption or flavouring purposes, but if the pesticide content is too high, the oil is relegated to non-consumable uses such as fragrance applications.

Shelf life

Buyers typically expect orange oil to have a shelf life of at least 1–2 years, depending on how the oil has been processed and stored. To meet buyer expectations, suppliers are required to provide detailed information on storage and expiration date. Buyers also expect that the oil will be stored in optimal conditions, such as in dark, airtight containers to prevent exposure to light, heat and air. In food and cosmetic applications, buyers prefer orange oil that remains stable and maintains its potency for the duration of its shelf life.

The following is an example of buying requirements for orange oil (cold-pressed sweet orange oil), covering key parameters like appearance, colour, odour, specific gravity, refractive index, and optical rotation:

Orange oil buying specifications

Table 4 : Orange oil buying specifications
Source : Diverse interviews

Category	Definition	Specification
Appearance		Clear, mobile liquid, free from sediment or cloudiness
Colour		Light to deep orange-yellow.
Odour		Fresh, sweet, and fruity, characteristic of freshly peeled oranges
Specific gravity	Oil density compared to water, that should fall within this range to meet quality standards.	0.842–0.850 at 20°C.
Refractive index	Indicates how light bends when it passes through the oil and is used to check purity and consistency.	1.470–1.475 at 20°C.
Optical rotation	The degree to which the oil rotates polarised light, which is an important characteristic for confirming the oil's chemical composition and authenticity	+95° to +99° at 20°C.
Flash point	A safety measure to ensure the oil meets required standards for handling and storage.	Typically around 48°C.
Solubility		Soluble in ethanol and fixed oils. Insoluble in water.
Chemical composition	Limonene is the primary active compound in orange oil, and a high concentration is a key indicator of oil quality.	Limonene content: 90–95%.

The following is an example of buying requirements for lemon peel, covering key parameters including appearance, colour, odour, specific gravity, refractive index, and optical rotation.

Lemon peel buying specifications

Table 5 : Lemon peel buying specifications
Source : Diverse interviews

Category	Specification
Appearance	Fresh peel: smooth, clean, and free from blemishes or signs of mould. Should not have significant cuts, bruises or damage. Dried peel: evenly cut or sliced into pieces or strips. Should be free from dust, foreign materials or any signs of contamination. Powder: fine, uniform texture, light yellow or pale brown in colour.
Colour	Fresh peel: bright yellow to light green, depending on maturity and variety. Dried peel: light yellow to pale brown. The drying process may slightly dull the colour.
Odour	Fresh: characteristic of lemons, with a strong, fresh, and tangy citrus aroma. Dried: similar to fresh, though slightly muted, retaining a robust lemon scent without off-odours or rancidity.
Chemical composition	Limonene content: 60–70% of the peel's essential oil Flavonoids Acid content Pesticide residue
Microbiological requirements	Total plate count (TPC): should be below 100,000 CFU/g for food-grade use. Yeast and mould: less than 10,000 CFU/g. Pathogens (e.g. E. coli, Salmonella): Absence in 25 g of the product, especially for food and cosmetic applications. Coliforms: Typically below 1,000 CFU/g.

2.6. Packaging and transport requirements

The EU classifies essential oil as a hazardous substance that require clear and adequate information for safe handling. Essential oil can be used across various industries, provided they meet regulatory requirements and obtain necessary authorisation for each application.

Packaging requirements

Citrus oil

Proper packaging is essential for maintaining the quality of citrus essential oil. Packaging is designed to protect the oil from contamination, preserve its quality, and prevent reactions with the material that it is contact in. Organic and conventional oils must be physically separated.

Buyers require that oil is stored in airtight, light-resistant containers, such as dark glass or aluminium, to preserve their properties and prevent oxidation. Packaging for exports must adhere to specific guidelines for safety and transport. For hazardous essential oil with a United

Nations (UN) number, there is UN-approved packaging, which is a critical requirement for the safe and legal transport of essential oils classified as hazardous materials. Citrus oils fall under this framework due to their flammability, volatility or chemical composition.

UN-certified packaging undergoes rigorous performance testing, including drop resistance, pressure tolerance, leak-proof integrity, and resilience under vibration or temperature fluctuations. These tests simulate the harsh conditions of global logistics chains. Beyond containment, UN-approved packaging features standardised labelling and markings that clearly indicate the nature of the contents and their hazards. This is vital for handlers, freight companies, customs officials and emergency responders, all of whom rely on this information to make safe and informed decisions during storage, handling, and in the event of an accident.

Citrus oil is typically exported in the following types of packaging.

1. Drums/barrels

- Material: most commonly made of food-grade stainless steel, lacquered steel or aluminium to prevent reactions with the oil.
- Capacity: standard sizes are 180–200 kg.
- Headspace: some containers are filled with an inert gas like nitrogen to preserve quality and prevent oxidation during transport.

2. Plastic drums

- Material: high-density polyethylene (HDPE) drums are used for shipping citrus oil, but metal drums are preferred for longer storage, due to potential interactions with the oil.
- Capacity: usually 20–50 kg, but larger drums of up to 200 kg are also available.

3. Glass bottles

- For small quantities or high-value oils, amber glass bottles may be used to protect the oil from light degradation.
- Capacity**:** Typically, 100–1000 ml in size.

Citrus peel

- Container must be made from clean, dry and non-reactive materials such as food-grade plastic, metal (like lacquered steel or aluminium) or cardboard. The choice of material helps prevent contamination and preserve the quality of the peel.
- Moisture protection, by using packaging that is moisture proof to prevent peel from absorbing humidity, which can lead to mould or deterioration.

Labelling

Citrus oil

Regardless of their intended application, labelling must specify purpose, with clear usage instructions and appropriate warnings, related to its inherent properties, traditional applications, and documented functional evidence.

An essential oil cannot be marketed for multiple uses under a single product label. According to the principle of non-cumulation, a product must have one defined function and purpose,

clearly stated on its label. This ensures that each product adheres to the relevant production standards, whether for cosmetics, food or food supplements. For example, lemon oil cannot be sold simultaneously for both cosmetic use and food flavouring. To offer it for multiple purposes, separate finished products must be developed, each complying with the specific regulations for that category and labelled accordingly, even if the oil itself is the same.

In all stages between production and incorporation into finished products, essential oil is classified as a "raw material" and must comply with regulations governing the production and marketing of substances and preparations. If oil is used as a food additive, the Codex Alimentarius standard is Codex Standard 107-1981[2]. This standard outlines essential composition and quality factors, permissible levels of contaminants, hygiene standards and labelling requirements for essential oils used in food. In the EU, essential oil is also subject to two critical pieces of legislation:

- "Classification, labelling and packaging" (CLP) Regulation (EC No. 1272/2008)[3] – This regulation ensures that substances (including essential oils) are correctly classified according to their hazards (flammability, environmental risk etc.) and are clearly labelled with the appropriate hazard symbols.
- "Registration, Evaluation, Authorisation, and Restriction of Chemicals" (REACH[4]) Regulation (EC No. 1907/2006) – Essential oil producers or importers must register their substances with the European Chemicals Agency (ECHA) for volumes exceeding 1 tonne per year. REACH registration includes detailed information on the chemical composition, toxicological and ecotoxicological profiles, safe use conditions and risk management measures.

The following labelling requirements are needed for export to the EU.

- Batch numbers for traceability of batches through markings and a registration system.
- English labels, unless otherwise specified by the buyer.

  – Include all of the following: product/INCI name, batch code, place of origin, exporter's name and address, date of manufacture and "best before" date, net weight, and recommended storage conditions.

- For organic products, the inclusion of the inspectorate's name/code and certification number.
- Documentation, including:

  – Technical Data Sheet (TDS)[5]
  or specification, which provides detailed information about:

    - The essential oil's properties, including product identification (Botanical name, Chemical Abstracts Service (CAS) number)
    - Physical and chemical properties
    - Extraction method
    - Storage conditions.

2 https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXS%2B107-

3 https://eur-lex.europa.eu/eli/reg/2008/1272/oj/eng

4 https://environment.ec.europa.eu/topics/chemicals/reach-regulation_en

5 https://www.cbi.eu/market-information/natural-food-additives/how-prepare-technical-data-sheets

- Certificate of Analysis (CoA)[6], Safety Data Sheet (SDS)[7] and GMO certificate[8] (if requested):
  - The CoA verifies that the essential oil batch meets specified quality standards
  - The SDS provides information on the safe handling and potential hazards of the essential oil
  - The GMO certificate confirms that the essential oil and its raw materials are free from genetically modified organisms.
- Certificate of origin[9], which states where the essential oil is produced and is used for customs clearance and trade agreements.
- Allergen declaration[10], which provides a list of any potential allergens; in citrus oil, these could be limonene or citral.

¨ Hazardous essential oil must display relevant hazard symbols and include risk and safety notices.

Citrus peel

¨ Sealing: Pack in airtight containers to keep them dry and protect them from external contaminants, to maintaining quality during transit.
¨ Labelling: Labels should include essential information such as product name and description, batch or lot number, country of origin, exporter's name and address, net weight, date of manufacture, "best before" date and storage instructions.
¨ Compliance: Packaging must comply with international regulations and standards related to safety, labelling and specific requirements of the importing country.

2.7. Food safety, sustainability and certification

EU legislation governing the purchase of citrus oil for food and cosmetic industries is stringent, and focuses on safety, traceability, and quality control.

Food industry

¨ General Food Law[11]: This sets the foundation for food safety standards in the EU. Citrus oil used in food must meet safety standards for contaminants including pesticide residues, and be traceable throughout the supply chain.
¨ Food additives[12]: Citrus oil used as a food additive must comply with approved usage levels and meet purity specifications.
¨ Maximum residue levels (MRLs) for pesticides[13]: Products that exceed the permitted residue levels cannot be sold in the EU.

6 Various examples of CoA are available on the internet, e.g. https://www.essentialoil.in/uploads/product_image/747885-orange-oil-coa.pdf
7 Various examples of SDS are available on the internet, e.g. https://www.praannaturals.com/downloads/msds/SDS_Organic_Essential_Oil_Orange_Sweet_OEOSWORANGECPMX655.pdf
8 https://www.ams.usda.gov/services/organic-certification/organic-basics
9 Various examples of certificates of origin are available on the internet, e.g. https://www.naturesfusions.com/reports/COO%20Singles/NF%20COO%202020%20Anise%20Essential%20Oil%20China%2020200506.pdf?srsltid=AfmBOoqoGd-X7qHsq3KF7mgQ9muYYUppwkmnktK6YOoQUwlGW5wECjA7
10 Various examples of Allergen Declarations are available on the internet: https://www.nhrorganicoils.com/uploads/20180830122551e_Grapefruit_Allergens.pdf
11 https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32002R0178
12 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008R1333
13 https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/start/screen/mrls

Cosmetic industry

- Cosmetic regulation: All citrus oil used in cosmetics and personal care products must meet strict safety and labelling standards, including safety assessments for ingredients, and it prohibits or restricts the use of certain substances.
- REACH[14] (Registration, Evaluation, Authorisation and Restriction of Chemicals): Citrus oil is classified as a chemical substance, and must be registered under REACH if produced or imported in quantities of 1 tonne or more per year. Manufacturers must ensure that the oils are free from hazardous chemicals and meet restrictions on certain substances.
- Allergen labelling[15]: Certain types of citrus oils contain allergens (e.g. limonene) that must be declared on cosmetic product labels if they exceed specific concentrations.

Regulatory compliance

- Safety regulations: Essential oil must comply with food safety standards in their respective markets, such as the EU General Food Law[16], the US Food and Drug Administration[17] (FDA) regulations, or Japan's Food Sanitation Act[18].
- Allergen information[19]: In the EU and other regions, oil needs to comply with allergen labelling requirements. Citrus oil may contain allergens like limonene, which need to be clearly stated on packaging.
- REACH compliance (Europe): Essential oil sold in Europe must adhere to the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation, that ensures it meets environmental and safety standards.

Sustainability

Buyers are increasingly seeking suppliers who can guarantee reduced waste during production, minimised water use, or use of environmentally friendly extraction processes. Ethical labour practices and a commitment to reducing carbon footprints are also key aspects of corporate environmental and social responsibility criteria.

Organic and sustainable sourcing

- Organic production and labelling: For citrus oil and peel to be labelled organic, they must comply with the EU organic production standards[20], including the use of organic farming methods and the exclusion of synthetic pesticides.
- Sustainable sourcing: Companies are increasingly required to include sustainable and ethical sourcing practices, particularly for natural ingredients like citrus oil.

Traceability

Buyers increasingly want information regarding the entire supply chain, from where the citrus was grown, cultivation methods, how it was processed into oil, and shipped to market.

14 https://environment.ec.europa.eu/topics/chemicals/reach-regulation_en
15 https://eur-lex.europa.eu/eli/reg/2023/1545/oj
16 https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32002R0178
17 https://www.fda.gov/cosmetics/cosmetic-products/aromatherapy
18 https://www.japaneselawtranslation.go.jp/en/laws/view/3687/en
19 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52017XC1213(01)
20 https://agriculture.ec.europa.eu/farming/organic-farming/organic-production-and-products_en

3. Supply

3.1. How do products reach the market

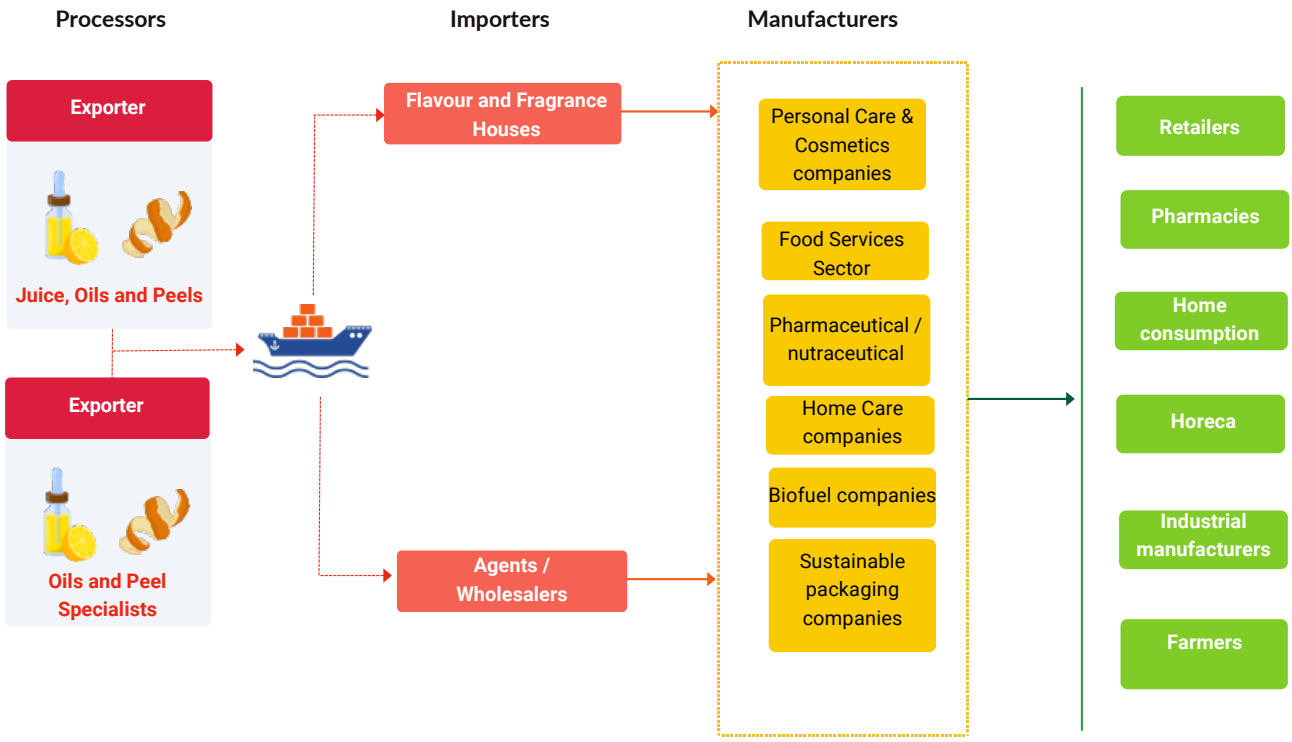


Figure 8: Processed citrus products.

Citrus oil and peel products are sold to a range of manufacturers in sectors like food, personal care, health, home cleaning and fragrances.

- Flavour and fragrance houses such as Givaudan, Symrise and Döhler (mainly based in Europe) play a central role. They import, process and distribute citrus-based ingredients globally to various industries.
- Agents and wholesalers, often based in trade hubs like Germany, the Netherlands and the UK, serve as intermediaries between producers and buyers. They manage logistics, regulatory compliance, and quality control, facilitating smooth trade.
- Processors are typically located in citrus-growing countries. These include specialised oil and peel producers and juice manufacturers that integrate oil recovery into their operations.

3.2. Suppliers in the market

The largest exporting country of citrus oil and peel is Brazil, reaching more than 30 thousand tonnes of exports in 2023. It is followed by Mexico, Italy, and the Netherlands, which all exported around 13 thousand tonnes in the same year (Figure 9).

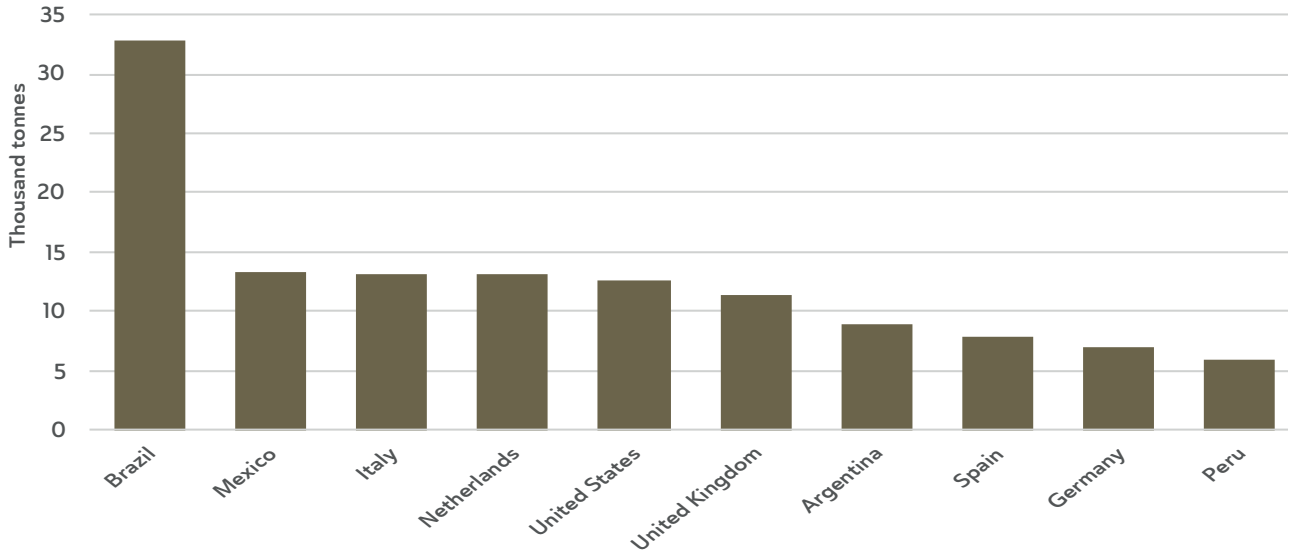


Figure 9: World's largest exporters of citrus oil and peel in 2023. Source: COLEAD based on CEPII BACI, Eurostat, UK Trade Info and IFPRI.

Citrus oil and peel are produced at scale in the largest citrus growing and exporting countries such as Argentina, Brazil, Italy, Mexico, South Africa and Spain.

Key European countries such as Germany and the Netherlands import and then re-export oil and peel either as component ingredients, or after further processing. In 2023, the Netherlands – the largest EU importer and second largest importer worldwide – exported 71% of the citrus oil and peel that were imported into the country. Germany, the second largest EU importer, re-exported 38% of their imports, demonstrating its importance as an end market in contrast to the Netherlands.

- **Orange**
  - Brazil is the world's largest producer and exporter of processed oranges.
  - USA, particularly Florida, is a key producer.
  - Argentina, Mexico and South Africa are also significant suppliers.
- **Lemon**
  - Argentina is the leading producer of processed citrus products.
  - Italy and Spain are key producers in Europe, known for high quality oils.
  - USA (California) is another important supplier.
- **Mandarin**
  - China is the top producer of mandarin oil and peel.
  - Italy is recognised for its high quality mandarin oil.
  - Brazil and Spain are also notable producers.
- **Grapefruit**
  - South Africa and the USA (Florida and Texas) are leading producers.
  - Argentina and Mexico also contribute significantly to global supply.

- **Bergamot**
  - Italy, especially the Calabria region, produces over 90% of the world's bergamot oil.
  - Côte d'Ivoire is a smaller producer of bergamot oil.

Oil and peel can contribute a significant share to exports. In Argentina, the lemon sector, "26%" of export is as essential oil, "10%" is peel and the balance is fresh fruit (42%) and juice (22%) (Source: IFEAT lemon report).

3.3. Competitive environment

The citrus essential oil sector is highly competitive, with established suppliers dominating the landscape. They have long-standing relationships with growers and buyers, giving them an advantage in terms of supply consistency, pricing, and market reach. Their experience allows them to maintain strict quality control and the ability to navigate complex regulatory frameworks in key markets such as the EU and the USA.

Additionally, the capital-intensive nature of oil extraction and the need for specialised knowledge in cold pressing and to a lesser degree distillation technologies, create barriers to the entry of new players. Companies such as Firmenich, Symrise and Givaudan dominate global trade, leveraging their scale to provide raw essential oils and value-added services such as blending, formulation and custom fragrance solutions, further reinforcing their stronghold in the sector.

Another important aspect is the large synthetic citrus oil sector that competes with natural cold pressed citrus oil by mimicking the aroma and characteristics of natural oils but at a lower cost of production. The demand for synthetic oil in perfumery, cosmetics and cleaning products is driven by more stable prices, consistency in quality, and availability. In industries like. Additionally, synthetic citrus oil can be tailored to meet specific formulation needs, making them attractive for large-scale manufacturers.

Key players in the synthetic fragrance and flavour industry such as Firmenich and Givaudan, are active in producing both natural and synthetic variants of citrus oil, providing options to cater to both sectors.

3.4. Seasonality

Citrus is mostly harvested in the colder months, between May and November in the southern hemisphere, and October to May in the northern hemisphere. The supply of oil follows this pattern and affects supply and prices. Brazil is a large orange juice producer, and the peak in the Brazilian production season creates a dip in prices and affects the demand of orange oil. It is also important that as oil has a long shelf life, it is possible to supply or source products outside of the harvest season.

3.5. Processing technologies

Cold pressing

Cold pressing (also known as expressing) is the most common method for extracting citrus essential oil, particularly from orange, lemon, lime and bergamot. The advantages of cold pressing are that it preserves the natural, fresh aroma and flavour of the citrus, and that no heat is involved, so the oil retains more of its natural properties. The process involves physical

pressing or mechanical grating of citrus peel to release the oil glands. Oil is stored in the peel's outer layer and is released through pressure. This production method typically involves four stages of production.

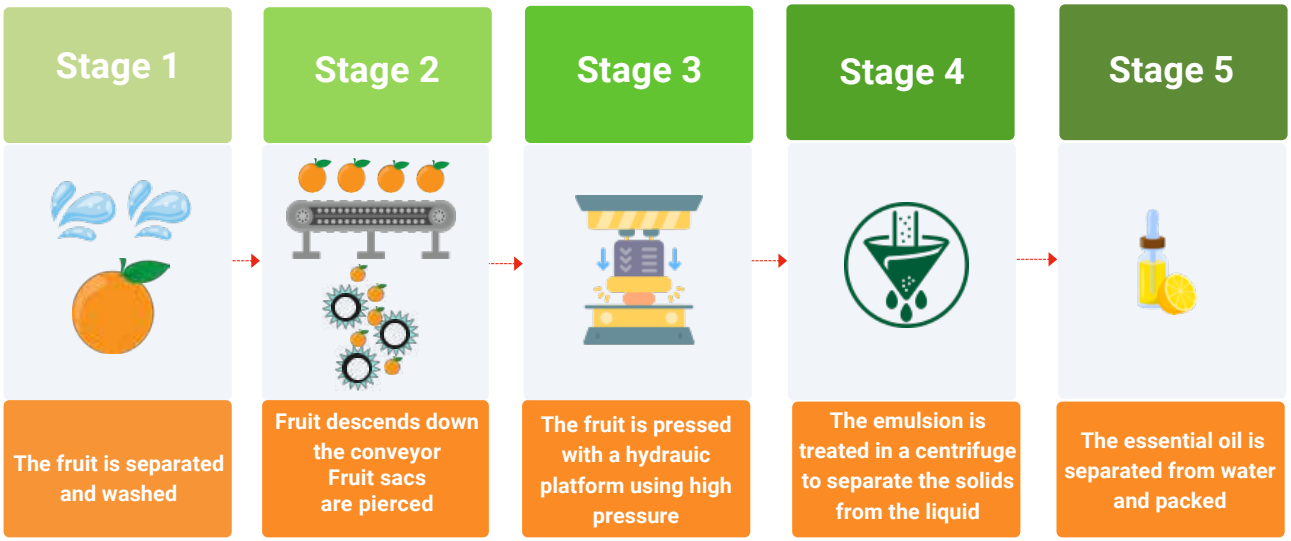


Figure 10: The cold pressed method of essential oil extraction.

Stage 1: Reception, sorting and washing

The essential oil of different citrus have different properties, so it is important to separate them. Fruit are cleaned to remove mildew, mould and dirt.

Stage 2: Extraction

Cleaned fruit are sent along a conveyor belt to an essential oil extractor having rotating rollers with needles that prick the oil vacuoles that causes the essential oil to spill out. Water sprayers then wash the oil into a collector.

Stage 3: Pressing

Fruit is pressed in a hydraulic platform under high pressure, to ensure that all the oil is released, and mixed with water.

Stage 4: Separation and refining

The oil and water are separated centrifugally, though the separated essential oil may still contain some water and peel wax and may require further refining. The simplest method is to place the crude essential oil at 5–8°C for 5–6 days when most water will separate out, and the peel wax will solidify and drop to the bottom. The pure citrus oil can then be collected from the top.

Stage 5: Packing

Some chemicals in essential oil (notably terpenes) are easily oxidised in sunlight, so it is necessary to put the oil in to airtight containers that are then stored out of sunlight.

Steam distillation

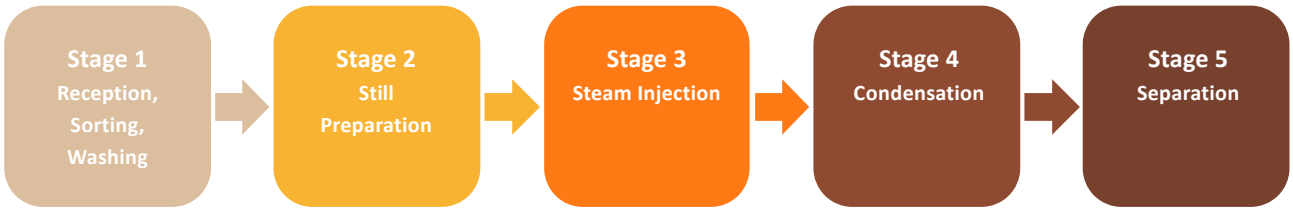


Figure 11 : The 5 stages of the steam distillation of the steam distillation

Steam distillation is usually used in applications when citrus oil is blended with other oil or used for specific applications. In this process, steam is passed through the citrus peel, the essential oil is vapourised, and t with steam and oil vapour condensed back into liquid form, and the oil separated from the water. The advantages of steam distillation are that it is suitable for large-scale production, and can be used to extract oil from a variety of plant, not citrus.

Stage 1: Reception, sorting, washing

Fruit is received inspected and sorted, with fruit that is spoiled or infected being separated and rejected, and f fruit that is accepted being washed to remove any residual dirt.

Stage 3: Steam injection

Steam is injected into a stainless steel still through an inlet. The steam passes through the citrus peel, releasing the essential oil by vaporising the aromatic molecules.

Stage 4: Condensation of vapour

The vaporised aromatic molecules then travel into the condenser. The condenser has two pipes: one for hot water to exit and another for cold water to enter, allowing the vapor to cool down and return to liquid form.

Stage 5: Separation of oil and water

The liquid that forms, consisting of both water and essential oil, is collected in a separator. Since oil and water do not mix, the essential oil typically floats on top of the water. It is then siphoned off.

Yields

The yields of citrus oil vary by fruit type, with oranges delivering the highest yields, and mandarins the lowest.

Table 6 : Citrus yields by fruit type

Citrus oil	Yield[21] – oil per tonne of fresh fruit	Yields – peel[22]
Oranges	3–4 kg	30–35%
Lemon	4 kg	35–40%
Grapefruit	2–4 kg	7–18%
Mandarin	3–5 kg	25–30%

21 https://www.miritz.com/products#c100, https://ifeat.org/wp-content/uploads/2023/10/IFEATWORLD-Autumn-2023-Socio-Economic-Report-Orange.pdf

22 The yield is the peel weight from l, https://pubs.rsc.org/en/content/articlehtml/2024/sm/d3sm01511d, https://weighschool.com/orange-weights/,

4. Challenges and opportunities

Table 7 : Challenges and opportunities for Citrus oil and peel

Challenges	Opportunities
¨ Difficult to compete with Brazil in orange processing, and with Argentina in lemon Processing, due to their large industries and competitive advantages. ¨ If not providing oil and peel as an adjunct to a juice business, this requires large capital investments for all equipment. ¨ If not part of juice processing, the cost of the oil needs to cover all overheads, substantially raising the price of oil. ¨ Climate change is increasingly affecting citrus production. ¨ Price volatility due to fluctuations in citrus production. ¨ Disease outbreaks (citrus greening). ¨ Trendy nature of oils in the cosmetic and personal care sector. ¨ Highly competitive sector, with synthetic alternative. ¨ Cheaper essential oil (not citrus) are available. ¨ Stringent buying/quality requirements and it differs by segment (cosmetics/food). ¨ Pesticide residue is a key factor in these products.	¨ There is increased demand in multiple growing sectors. ¨ Diverse product applications and more innovations coming through on the market. ¨ Organic and natural ingredients are increasingly in demand. ¨ Sustainably sourced products (Fairtrade) are advantageous. ¨ Innovations in processing and extraction technologies are opening up possibilities for higher quality. ¨ Growing demand globally, especially when key juice producing markets experience shortages. ¨ As a by-product of juice processing, this offers improved profitability. ¨ Emerging markets, especially in East Asia. ¨ Long shelf-life allows for oils to be available throughout the year, and longer.

5. Ingredients for success

5.1 Expanding product portfolios

An adjunct to juice

The dominant business model for commercial citrus oil production is as an adjunct to juice production. This exposes companies to less risk and allows for competitive production. of a far more diversified portfolio that is helpful for managing risk. Citrus processing offers opportunities beyond essential oil, as diversifying into products like dried peel or peel powder can maximise use of raw materials and increase revenue streams. Dried peel for instance, can be used in teas, potpourri or as a food additive.

The global market for citrus oil is rarely oversupplied across all fruit types at the same time. For example, there may be an abundance of orange oil, while demand for lemon, tangerine or grapefruit oil might remain steady, ensuring a stable source of revenue. Added diversity allows businesses to build resilience, ensuring long-term stability in an often volatile market.

5.2 Organic and natural

Competing directly with large South American suppliers in the orange oil and peel market can be challenging, while focusing on market segments with unique value such as organic or natural products can provide a strategic advantage. The organic citrus market is an expanding segment in the global food and essential oil industry. The supply of organic citrus is growing, making it an attractive area as consumers become more aware of the benefits of organic produce. By offering organic oil, producers deliver a purer, more natural product that appeals to consumers who prioritise health, wellness and environmental sustainability. Additionally, organic certification builds trust with international buyers, opening doors to long-term partnerships with specialised distributors and retailers.

5.3 Market access

Due diligence

A feasibility study is a vital first step to assess market potential, consumer fragrance or taste profiles, safety, price competitiveness, and overall market opportunities. Even if a new product meets a market need, however, introduction can be expensive and does not guarantee uptake. For less commonly used products, strong partnerships with importers or distributors is more important as they create the demand and establish a market.

Value proposition

The citrus essential oil sector has established suppliers, so to compete effectively, new producers must differentiate their value proposition of high quality with distinctive fragrance profiles, and/or a focus on certified organic oil and peel that cater to niche market segments to meet this growing global demand. Many retailers and end-users also prioritise eco-friendly production methods, such as water-wise or low-waste processes.

Capitalising on gaps

In times of shortage, buyers may be more willing to experiment with new profiles and suppliers. During such periods, it is essential for suppliers to highlight their reliability, professionalism and transparency, alongside clear communication on certification, production volumes and quality specifications to establish trust and secure orders.

Building strategic partners

For new producers, cash flow is a challenge when market entry requires large upfront investments. Building strategic partnerships with importers helps mitigate this risk. By securing guaranteed sales volumes before the start of the season, producers can ensure a stable cash flow, which in turn allows a focus on improving quality and efficiency. Partnerships also provide valuable market insights, enabling producers to align products with consumer demands and market trends. A parallel option to break into international markets is to work with experienced distributors or agents who have established relationships with key buyers who can reduce barriers to market entry and offer guidance on regulatory compliance, certification and customer preferences.

5.4 Quality

Efficient supply chains

Fruit or peel freshness has a direct impact on oil quality, and delays lead to deterioration that reduces marketability. Efficient logistics are essential to preserving quality, and when immediate processing is not feasible, proper storage conditions are necessary to prevent spoilage or degradation.

Quality management

Research institutions or accredited laboratories are needed to test and analyse, as chemical composition is an essential for regulatory requirements and for buyers, importers and retailers. Producers can also compare their product with the requirements of prospective buyers. Analysis is especially important in identifying allergens and other risks, which are critical with fragrances and cosmetics.

Standardisation

Offering a consistent product is vital in a competitive global market, that be achieve by blending products (oil, peel, peel powder) from different harvests or regions to ensure uniform quality across batches. Monitoring cultivation and harvesting practices is also essential, as these factors greatly influence oil quality. Producers must develop clear specifications for their products, including the chemical profile and allergen information, and provide data to buyers through Product Fact Sheets. In a market that demands high standards and transparency, maintaining strict quality control is a very important ingredients for success. By prioritising quality at every stage, from sourcing raw materials to processing and marketing, producers build a reputation for excellence and gain a competitive edge in the citrus processed oil and peel sector.

6. Further reading

For further reading on citrus oils and peels, please see below:
Gupta, A.K., Kour, J. and Mishra, P. (eds.) (2024) Citrus fruits and juice processing and quality profiling. Singapore: Springer Nature Singapore Pte Ltd.

Europe:
CBI – Centre for the Promotion of Imports from Developing Countries (CBI: www.cbi.eu)

- CBI (2018) Exporting essential oils for aromatherapy to Europe. https://www.cbi.eu/market-information/natural-ingredients-cosmetics/essential-oils-aromatherapy
- Details market demand, buyer requirements, and export tips for essential oils, including citrus variants, targeting the European market.
- CBI (2019) Exporting essential oils for fragrances to Europe. https://www.cbi.eu/market-information/natural-ingredients-cosmetics/essential-oils-fragrances
- Focuses on the fragrance industry's requirements, trends, and opportunities for essential oil exporters.

EU Access2Markets (website; formerly Market Access Database)

- https://trade.ec.europa.eu/access-to-markets/en/home
- Essential for understanding citrus oil and peel import requirements into the EU, like labelling, safety, and customs duties.

United States of America:
Food and Drug Administration (FDA)

- FDA (2024) Importing food products into the United States. https://www.fda.gov/food/food-imports-exports/importing-food-products-united-states
- Outlines the key compliance measures for essential oils used as food flavourings or in cosmetics.

United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) – Phytosanitary Requirements

- USDA APHIS (2024) Phytosanitary treatments for imported commodities. https://www.aphis.usda.gov/plant-imports/treatments
- Addresses entry protocols for plant-derived materials, including peels.

Asia:
Association of Southeast Asian Nations (ASEAN) Trade Repository (website)

- http://atr.asean.org
- Provides trade rules, tariffs and SPS (sanitary and phytosanitary) measures for citrus derivatives in Southeast Asia.

General Administration of Customs of the People's Republic of China (GACC) (website)
- http://english.customs.gov.cn
- Details registration and clearance requirements for citrus oil and peel exporters shipping to China.

SECTOR STUDY: CITRUS OIL AND PEEL

1. Fresh citrus
2. Citrus juice
3. **Citrus oil and peel**

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