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Diversification of Rose-Based Products for Sustainable Income Generation and Rural Entrepreneurship

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Abstract

Roses are among the most important aromatic and floricultural crops worldwide, valued not only for their ornamental use but also for their applications in perfumery, cosmetics, food and traditional medicine. This review critically examines value-addition opportunities in roses with special emphasis on Rosa centifolia, a species renowned for its rich aroma and phytochemical composition. The article synthesises global and national trends in rose cultivation and highlights the increasing shift from fresh-flower markets toward processed products that offer higher and more stable economic returns. Major value-added rose products reviewed include essential oils, rose water, dried petals, edible preparations such as gulkand and syrups, as well as medicinal and cosmetic extracts. The review discusses key processing technologies, including steam and hydro-distillation, solvent extraction, drying methods and food-grade preservation techniques, with relevance to small, medium, and large-scale operations. Economic analyses from the literature indicate that processed rose products can significantly outperform fresh flowers in profitability while reducing post-harvest losses and market volatility. The Review article also identifies critical constraints limiting value addition, such as outdated extraction methods, inadequate post-harvest handling, weak supply chains, lack of quality certification and insufficient policy support. Emerging opportunities related to consumer preference for natural and organic products, technological innovation and rural entrepreneurship are highlighted. Overall, the review provides a comprehensive and policy-relevant synthesis, positioning value addition in Rosa centifolia as a viable pathway for income diversification, rural development, and sustainable growth of the floriculture sector.

Keywords: *Rosa centifolia*; Value-addition; Distillation; Entrepreneurship; Aromatics.

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Introduction

The roses have long been appreciated because of their beauty, scent, and symbolism of culture and play an important role in horticulture worldwide (Meziouy et al., 2025). The genus rosa consist around 200 species and cultivars which vary in their colour, appearance, smell and adaptability (Basu et al., 2015). *Rosa centifolia*, which is traditionally referred to as the cabbage rose, is one of them, with its unique scent profile, the essential oil, and the ability to be subjected to various kinds of processing (Haban et al., 2023). Roses are cultivated not only as ornamental cut flowers but also as raw material for perfumery, cosmetics, food industries, herbal products and natural wellness sectors (Mileva et al., 2021). They are one of the most commercially important floricultural crops of aromatic nature due to their multipurpose nature and cultural significance (Shabbir et al., 2009). Growing scientific attention to antioxidant, antimicrobial and therapeutic properties of roses further strengthens the potential for value-addition, especially in the case of such rose species as *Rosa centifolia*, which have high aromatic and bioactive properties (Nikolic et al., 2013).

The global floriculture industry has grown steadily over the past few decades, owing to the changing lifestyles, growing disposable earnings and the growing value in the decorative and aesthetic use of floricultural products. These factors, such as urbanisation, development in the hospitality industry and globalisation of the gift-giving culture, have further fuelled the demand for cut flower products (Adebayo et al., 2020). Roses are the most represented ornamental crops traded internationally as cut flowers (Faust et al., 2021). Although fresh-flower markets are still relevant, the processed rose products like essential oil, rose water, concrete, absolute, dried petals, and edible rose preparations can generate higher economic returns throughout the year (Koushal et al., 2024). They are less cumbersome to store, ship and sell in comparison to fresh flowers, and they are appealing to sectors that specialise in cosmetics, wellness and natural plant-based ingredients (Mileva et al., 2021). Such evolving perception gives new market chances to growers, especially those in developing countries, to increase income by engaging in value-added activities (Shah et al., 2022).

Although there is a great demand worldwide, most rose-growing farmers in Asia, Africa and other developing countries continue to make low profits as they majorly sell fresh flowers (Usman et al., 2014). Fresh roses are very perishable and diminish in value and have a low commercial life (Kalinowski & Dole, 2024). The issue of poor post-harvest handling, lack of cold-storage facilities, inefficient transport systems and unstable market prices contributes to huge economic losses (Cardoso, 2025). The occurrence of seasonal changes and excess due to the peak flowering seasons leads to extreme price volatility, which has an impact on the revenue of small cultivators (Momotaz & Banik, 2020). One of the key problems is the unawareness, training and access to rose-processing technologies (Parmar et al., 2021). As a result, a significant portion of the roses is sold as raw material, whereas industries in other nations make substantial profits selling roses as value products (Moody et al., 2014).

In spite of the high potential of *Rosa centifolia* and other rose species to be used in value addition, most farmers are not aware of the contemporary methods of processing, quality regulation and the new market requirements (Parmar et al., 2021).

Small growers cannot utilise this potential because of limited use of technology and a lack of small-scale processing facilities (Dhillon and Moncur, 2023). Thus, value-addition practices, including training, transfer and creation of cottage-level processing plants, are necessary to minimise post-harvest losses, stabilise incomes of the farmers and build strong floriculture-based economies in the region (Koushal et al., 2024).

Value addition in roses refers to the process of transforming the raw floral mass into the processed products with higher market value (Mebakerlin and Chakravorty, 2015). A wide range of value-added products is derived from roses, such as essential oils, rose water, hydrosols, concrete, dried petals, potpourri, herbal teas, syrups, jam (gulkand), natural fragrances, skin-care preparations and nutraceutical extracts (Priya et al., 2021). Rose essential oil of *Rosa centifolia* is one of the most useful natural oils since it needs a lot of petals to be used, and its aromatic components are rich (Mileva et al., 2021). The demand for rose water in culinary, medicinal and cosmetic industries is still high (Gouthami et al., 2024). Herbal teas and wellness products use dried petals and powders, which have the advantage of being antioxidants and soothing to the body (Rani et al., 2013). Such value-added products allow farmers and businesspeople to diversify their income, reduce waste and enter the high-value niche markets (Choudhary et al., 2024). They also enhance effective use of resources and facilitate cottage-level businesses, which are especially helpful to women and rural populations (Basnayake, 2023).

Rosa centifolia is also particularly appropriate in value addition due to an abundance of aromatic compounds like citronellol, geraniol and nerol as well as phenolic antioxidants (Gochev et al., 2008). Its essential oil has long been used in perfumery as a warm and rich floral fragrance (Khatib, 2024). Its flowers are edible and can be used as jams, syrups, teas, candies and natural flavourings (Faisal et al., 2022). Its medicinal properties, such as anti-inflammatory, antimicrobial, digestive and stress-relieving properties, have been scientifically studied and are growing interest in pharmaceutical use (Katsukawa et al., 2011). *Rosa centifolia* cultivation and breeding of plant varieties increase yield, fragrance and adaptability have a lengthy history in countries like Pakistan, India, Turkey, Morocco and Iran, and have been implemented to support the growth of value-added industries (Akhtar et al., 2014).

This review aims to offer a systematic insight into the value-added activity of roses with a particular emphasis on the rose centifolia. It analyses the trends in rose production at the international and national levels and points out how the growing demand by cosmetic, pharmaceutical, and natural wellness sectors is transforming rose use beyond ornamentation. The review assesses the existence of various value-added rose products such as essential oils, rose water, dried floral materials, edible preparations, medicinal extracts and processing procedures of these products on a small, medium and commercial level. It also examines the economic relevance of value-addition procedures to growers who experience difficulties in terms of fluctuation of prices, post-harvest losses, restricted storage and market. Through the production of value-added products, rose growers will be able to earn more constant revenue and minimise wastage, coupled with new entrepreneurial potentials. Moreover, the review defines significant

technological and institutional limitations which may be barriers to the expansion of rose-processing industries. It also points to the emerging opportunities due to the development of distillation technologies, climate-resistant aromatic varieties, maximising low-cost processing units, and the growing market in organic and natural products in the world. Generally, the purpose of this review is to advise farmers, researchers, policymakers and development agencies to engage in strategies that encourage profitability, sustainability and diversification in the rose sector. Enhanced value-added activities can turn roses, particularly *Rosa centifolia,* into poverty alleviation and centred entrepreneurship triggers in rural areas.

Methodology (Review Approach)

A narrative and thematic review method was used to conduct this review to synthesise peer-reviewed data on the value-added products and Rosa centifolia. There was a detailed search in various databases, e.g., Google Scholar, Scopus, Web of Science, and ResearchGate by the keywords, e.g., Rosa centifolia, rose essential oil, rose water, floriculture value chains, rose processing technologies and economic analysis of roses. Relevance screening of the selected articles was done based on peer-reviewed articles published within the last 20 years in the English language and on regional reports and industry figures.

The literature review incorporates the research on the floriculture value chains, processing technologies, and the market trends with a comparative analysis of the economic and post-harvest factors. Global and regional standpoints were both taken into consideration, with the focus put on the variations in production trends, market penetration and profitability. Data collected by small, medium and commercial-scale operations were examined to give an insight into the economic sustainability and obstacles of rose-based value addition. The strategy was also meant to find gaps in knowledge, technical constraints, and new opportunities to inform future research and policy interventions.

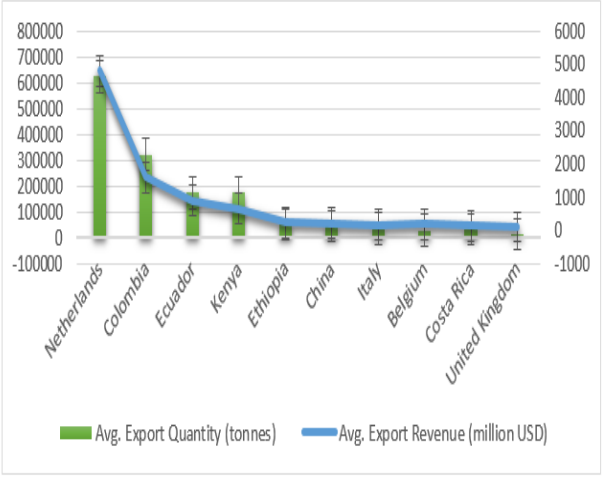
Global and National Status of Rose Production

Current Trends in Global Rose Cultivation

The roses are commercially important floricultural crops in the global market, which have diverse markets including cut flowers, perfumery, cosmetics and wellness businesses (Ellermann Flowers, 2025). There is limited available global data on roses, but the international trade in fresh cut flowers under Hs code 060310 is commonly used as a proxy since the largest portion of international cut-flower exports is by roses (World Bank, 2023). International trade is concentrated in countries such as the Netherlands, Colombia, Ecuador, Kenya and Ethiopia, where advanced greenhouse systems and efficient post-harvest handling dominate global cut-flower exports (Rhema Flowers, 2025). Worldwide cut-flower commerce has reached about 10 billion dollars in 2023, with the Netherlands topping the exportation of the goods, with figures of 4.08 billion dollars, in Colombia with 2.07 billion dollars, Ecuador with 1.1 billion dollars, and Kenya with 660 million dollars (Observatory of Economic Complexity, 2023). The recent tendencies indicate the transition toward the production of aromatic and industrial rose varieties, leaving ornamental cut-flowers, caused by the increased demand for essential oils, rose water and natural cosmetics (IMARC Group, 2024). It is estimated that the oil

market in the world is worth $2.7 billion in 2024 and is set to increase at a compound annual growth rate (CAGR) of 11.6, with the market reaching up to 45.5 billion in 2034 (Zion Market Research, 2025). Climate change and changing consumerism have increased the pace of producing climate-tolerant and high-yielding rose varieties, to provide flexibility to various agro-climatic regions and enable the production systems to be sustainable (Ikram et al.,2025). This shift highlights the increasing economic and industrial relevance of Roses in the non-traditional context of floriculture (Bhavya et al., 2025).

Figure 1. Average Cut-Flower Export Quantity and Revenue of Major Producing Countries (Proxy for Global Rose Trade, 2018-2024)



Note: Figure 1. Data represent average export quantity and revenue for fresh cut-flowers (HS 060310). Roses account for the largest proportion of the global cut-flower trade; therefore, cut-flower export data is used as a proxy for global rose cultivation trends. Source: World Bank WITS database.

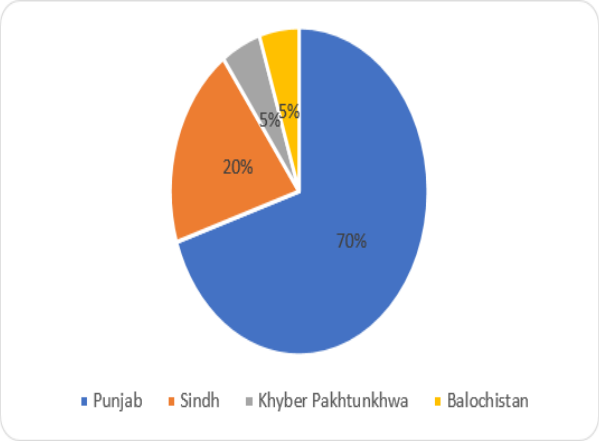
National Production Trends and Regional Hubs (Pakistan)

The rose cultivation in Pakistan has become an important segment of the floriculture sector, which has brought economic and cultural benefits to the agricultural industry. Despite the fact that floriculture covers a relatively low portion of the total farmland, roses are still some of the most commercially relevant ornamental plants considering their high demand for fresh flowers, essential oils and finished articles (Ahmad et al., 2010). In Pakistan, the prevalent area of land under the cultivation of roses is about 9,480 acres (3,835 hectares) and yields close to 42,660 tonnes each year (Ahmad, 2023). This sector is dominated by Punjab province, which enjoys favourable Agro-climatic conditions, having nursery networks near large urban markets. Pattoki, Kasur District, in Punjab, known as the City of Flowers, is used as the biggest floriculture centre since it has hundreds of nurseries and serves the entire country with flowers. Pattoki is strategically situated along the Lahore Multan corridor, and its large infrastructure system has made it the centre of rose trade and value-added production, such as the extraction of essential oil and the preparation of bouquets (Graana.com, 2024; Arab News PK, 2024).

Additional districts of Sindh, such as Hyderabad and Matiari, where thousands of acres of roses are planted, and the supplies market of Teen Hatti, Karachi, at wholesale prices. The areas altogether supply as many as 40 truckloads of roses a day, although the salinity of the soil and flooding caused by the climatic conditions are the obstacles (Memon et al., 2015; Arab News PK, 2024). In Khyber Pakhtunkhwa, Balochistan, Azad Kashmir, northern Pakistan, there are smaller production centres that mainly cater to local markets and small-scale processors (Dawn, 2021). Most of the commercial rose production is concentrated in Punjab, where surveys show that 526 hectares are under cut rose production, which means that there is an increasing trend towards greenhouse farming and production based on export (Ahmad et al., 2010). This is a regional concentration that highlights the possibility of value addition like rose oil, rose water

and dried petals that can go a long way to increase profitability and make Pakistan stand out in the global floriculture market (Associated Press of Pakistan,2025).

Figure 2.Estimated average provincial shares of rose (Rosa spp., including Rosa centifolia) production in Pakistan.



Note:2: Official province-wise rose production data are not published; shares are proxy-based estimates derived from floriculture cluster reports and regional studies. Source: Ahmad et al., 2010; Planning Commission of Pakistan & CABI, 2020; Memon et al., 2015; Ministry of National Food Security & Research, *2023-24.*

Concept of Value Addition in Floriculture

Value addition in floriculture is the process of converting fresh flowers into more valuable products that improve the market attractiveness, shelf life and profitability (Koushal et al., 2024). It expands the floriculture activities beyond mere cultivation to processing, preservation, packaging and product diversification (Mebakerlin and Chakravorty, 2015). Value addition has been found to enhance the floriculture value chain by developing new market segments, enhancing product quality and creating consumer demand (Singh, 2025). Growers and rural entrepreneurs will find it particularly valuable as they will be able to increase the profitability of the same level of production, decrease reliance on volatile fresh-flower markets and have more sustainable sources of income (Shah et al., 2022). It is consistently reported that value-added processes like drying, extracting essential oils, floral tea preparation, potpourri, perfumes and natural dyes can significantly decrease the post-harvest losses that can be extremely high in the floriculture industry because of poor handling and perishability (Bodh et al., 2024). To rural communities, value addition creates an off-farm job, promotes small agro-based income-generating enterprises and enhances the local economies by diversifying income streams (Chatterjee and Das, 2017). It also provides special women-focused entrepreneurial prospects, as many of the value-added operations like drying, grading, packing and home-based processing involve minimal investments, skills-based, and culturally acceptable to women in rural South Asia (Basnayake, 2023). Consequently, value addition not only enhances profitability but also leads to a reduction in poverty, empowerment, and inclusive growth in the floriculture industry (Srivastava et al., 2023).

Rose-Based Value-Added Products

Essential Oils and Perfumes

Essential oils and perfumes obtained with the help of *Rosa centifolia* are the most lucrative type of rose-related products since they are highly aromatic, and the demand is strong across the world (IMARC Group, 2024). The extraction of *R. centifolia* flowers is based on the accepted methods, including steam distillation, solvent extraction and hydro-distillation (He & Putra, 2025). The use of steam distillation is also justifiable, as it does not cause the loss of the natural aroma profile of the distillation product, whereas hydro-distillation is still applicable to the small and middle-scale distillation enterprises (Mohamadi et at., 2013). Solvent extraction

is more expensive, but with a greater fragrance power, concrete and absolute products, it is the choice of high-end perfumery (Erbas & Baydar, 2016). *Rosa centifolia* essential oil contains common aromatic compounds such as citronellol, geraniol, nerol, phenylethyl alcohol and traces of esters which form the warm, sweet and honey-like smell (Shabbir et al., 2009). The oils also have therapeutic properties; the oil can be used in aromatherapy as well as wellness markets (Hongratanaworakit, 2009). Demand in the market of the *R. centifolia* essential oil is always high because of its application in the luxury perfumes, high-quality cosmetics, natural skin care products and herbal therapeutic dispensations (TechSci Research, 2023). The scale of production may be as small as cottage industry, using simple stills, to medium, using better boilers, condensers and stainless-steel distillation units, and large commercial processors with advanced vacuum distillation, solvent extraction plants and quality-control laboratories to ensure the international standards (Haban et al., 2023). This flexibility and high-value aroma compounds of *R. centifolia* make its essential oils and perfumes a high-value segment with an excellent rural entrepreneurship and women-based enterprise and export-focused development of floriculture (Katekar et al., 2023).

Rose water

One of the most produced value-added items of *Rosa centifolia* is rose water, the product characterised by its pleasant aroma, calming effects and wide usage in the cosmetic, wellness and food segments (Dobreva et al., 2023). It is normally extracted by hydro-distillation, in which fresh rose petals are heated with water, and the condensed vapour is used to extract volatile aromatic compounds into the final distillate (Pal et al., 2013). Small-scale production uses the simple copper or stainless-steel stills that are directly heated and therefore makes the process available to small-scale industries in households and cottage industries (Mohamadi et al., 2013). Mass processors have sophisticated distillation plants with temperature controls, stainless-steel tanks and enhanced condensation units to maintain uniform quality, purity, and microbial safety (Fereidani and Uctug, 2023). In the current commercial units, fractionation and closed-loop systems are commonly used to improve efficiency and preserve fragile aroma compounds (Bravo, 2019). The market of rose water is high based on its multitasking. It is also used in cosmetics as a natural toner, skin coolant, creams, lotions and facial mist ingredient because it is a mild astringent with anti-inflammatory action (Wos and Kietyka, 2021). It is applied in aromatherapy, traditional medicinal system and herbal formulations in the wellness industries in order to ensure relaxation and skin well-being (Wang, 2024). It is also important in terms of its culinary value as it is utilised as a flavouring agent in sweets, beverages, bakery and traditional dishes throughout South Asia and the Middle East (Miller, 2025). Low cost of production, limited capital needs and wide market demand make rose water an enticing value-added product to small growers and rural businesspeople who deal with the *Rosa centifolia* (Grand View Research, 2025).

Edible Rose Products (Gulkand, jam, syrups, teas)

Gulkand, rose jam, and syrups, as well as herbal teas, are an important part of the value addition of rose, because they possess a unique nutritional, therapeutic and cultural value (Marchioni et al., 2021). Such products are rich in bioactive substances like phenolics, flavonoids,

anthocyanins, vitamins and natural antioxidants that are helpful in promoting digestive health, alleviating the impact of heat stress and overall well-being (Kayahan et al., 2024). Gulkand is a rose petal-sweetened preparation that is traditionally used in medicine as a cooling, laxative and rejuvenating agent (Shukla et al., 2024). The process of rose jam and syrup involves heating the petals using sugar syrup, then concentrating to retain aroma and colour (Garden-Robinson, 2024). Rose teas are made by drying the petals in the shade or controlled-dehydration conditions to maintain the flavour and phytochemical integrity (Jeanroy, 2025). Preservation procedures are aimed at low moisture storage, reduction of microbial growth and enzymatic browning and small-scale producers tend to use sundrying or dehydrators. Commercial units are dependent on the food-grade dryers, pasteurization and vacuum-packed packaging (Lucero, 2020). There is a rising consumer acceptance of edible rose products owing to increased demand for natural, herbal and familiar cultural foods with functional purposes (Mordor Intelligence, 2025). Among trends in the market, there is an increase in wellness foods, organic products and botanical beverages, creating great commercial prospects with *R. centifolia* (Zhao et al., 2025). The standards of safety are crucial; the production should be of food-grade quality control, ensuring it must be hygienically handled, use of potable water, low microbial load and the absence of contaminants like pesticides, heavy metals, or artificial colourants (Chetia et al., 2025). Ease of labelling, batch testing, and compliance with the national food safety standards can guarantee that the edible rose products can match the expectations of the consumers, and they can be trusted by the market (U.S. Food and Drug Administration, 2024).

Dried Flowers and Decorative Items

Rosa centifolia dried flowers make a multi-purpose type of value-added products that are commonly used in crafts and home decoration, and in the production of potpourri (Chin et al., 2015). The process of drying preserves the natural colour, shape and fragrance of the petals to be used even after harvest (Bhatta et al., 2020). The easiest method is air-drying, where petals or entire flowers are placed in dark and airy rooms to maintain colour without any microbial proliferation (Lakshmi et al., 2019). Controlled heat is used to hasten the drying process in an oven and is appropriate in small and medium units that require a quicker turnover (Chin et al., 2015). The most sophisticated technique is freeze-drying, as it leaves excellent colour and texture in the dried flowers, which is suitable in the high-end decorative markets (Merivaara et al., 2021). Craft products, including greeting cards, wall hangings, floral art, candles, soaps, handmade gift items, etc., are made of these dried materials (Shah et al., 2022). Another sector in which they provide is the decoration industry of events, interior decoration and perfume blends such as potpourri, in which dried petals are combined with essential oils and natural fixatives (Bhatta et al., 2020). Dried rose products can specifically be used in rural processing units of low cost because they need little equipment and less energy consumption, as well as the availability of the raw material locally (Lakshmi et al., 2019). The industry is not expensive, as small cottage businesses can use rudimentary drying racks, dehydrators and simple packaging equipment (Chin et al., 2015). As the popularity of decorating with sustainable flowers grows, and the use of hand-made items grows, the dried *R. centifolia* flowers as a source of a value-

added product form a sustainable and profitable proposition to rural communities (Bhatta et al., 2020).

Pharmaceutical and Cosmetic Applications

Belonging to the category of bioactive compounds, *Rosa centifolia* has flavonoids, phenolic acids, tannins, anthocyanins, terpenoids and aromatic alcohols like phenylethyl alcohol (Vo et al., 2023). These compounds contain antioxidant, anti-inflammatory, antimicrobial, and calming effects and thus, the species are of great use in pharmaceutical and cosmetic preparations (Masyita et al., 2022). *R. centifolia* extract is employed in herbal drugs to treat stress, enhance digestion, and improve the health of the skin and mildly infected (Ghasemzadeh et al., 2018). Rose extracts, hydrosols, and essential oils are applied in toners, creams, serums, soaps and hair products and in cosmetics as they have a light fragrance and calming effects on the skin (Kwon et al., 2010). Product diversification is on the rise in the industry; there is more demand for natural and plant-based ingredients (Kumar et al., 2020). This has spurred innovation in rose gels, face masks, lip balms, therapeutic oils and dermatological preparations (Khan et al., 2021). The therapeutic value coupled with the safety and preference of natural products by consumers places *Rosa centifolia* as a high-value raw material in the pharmaceutical and cosmetic industry, with a promising market and a good opportunity of high specialized value-added processing (Astuti et al., 2019).

Table 1. Major Value-Added Products Derived from Rosa centifolia.

S. No	Category	Product Type	Processing Method	Key Features / Uses	Reference
1	Aromatic Products	Essential oil	Steam distillation/hydrodistillation	Perfumery, aromatherapy	(Baydar & Baydar, 2005)
2	Aromatic Products	Rose absolute	Solvent extraction	Premium perfumery	(Zhao et al., 2016)
3	Aromatic Products	Rose water	Hydrodistillation	Cosmetics and wellness	(Yang et al., 2024)
4	Edible Products	Gulkand	Sun-maceration with sugar	Cooling tonic	(Shukla et al., 2024)
5	Edible Products	Rose jam	Heating with sugar	Culinary, bakery	(Garden-Robinson, 2024)
6	Edible Products	Rose syrup	Concentrated extraction	Beverages, desserts	(Garden-Robinson, 2024)
7	Edible Products	Rose tea	Shade/oven drying	Functional beverage	(Jeanroy, 2025)
8	Decorative Products	Dried petals	Air/oven/freeze drying	Potpourri, craft	(Shah et al., 2022)
9	Decorative Products	Dried whole flowers	Freeze-drying	Premium décor	(Shah et al., 2022)
10	Decorative Products	Potpourri	Mixing petals + oils	Home fragrance	(Bhatta et al., 2020)
11	Cosmetic Products	Rose extract creams	Solvent/water extraction	Skin hydration	(Kwon et al., 2010)
12	Cosmetic Products	Facial toners/mists	Hydrosol-based	Skin soothing	(Khan et al., 2021)
13	Cosmetic Products	Rose soaps	Essential oils	Aromatherapy skincare	(Astuti et al., 2019)
14	Pharmaceutical Products	Herbal extracts	Alcoholic/water extraction	Antioxidant activity	(Baydar & Baydar, 2005)

15	Pharmaceutical Products	Therapeutic oils	Infused/distilled	Anti-inflammatory	(Moreira et al., 2019)
16	Pharmaceutical Products	Topical gels & ointments	Extract-based formulation	Anti microbial	(Khan et al., 2021)

Economic Analysis of Rose Value Addition

Value addition will turn roses into a high-value portfolio of low-margin products, which guarantee higher financial returns and market stability (Thakur et al., 2019). When there is oversupply, growers will have to sell at a low price during peak harvest seasons, leading to unprofitable growth (Katekar et al., 2022). Processed items like rose water, essential oils, dried petals, herbal teas, gulkand, syrups and cosmetic extracts, on the other hand, have a long shelf life, high price tags and access to larger local and international markets (Baydar and Baydar, 2005). Turning perishable flowers into long-lasting, branded products, value-added businesses lessen reliance on price volatility daily, maximise earnings and mobilise possibilities among small farmers, women entrepreneurs and rural cottage industries (Shah et al., 2022). This is an economic resilience through strategic change, which enhances the diversity of revenues and sustainable floriculture systems (Thakur et al., 2019).

Comparative Cost-Benefit Analysis: Fresh vs. Processed Products

Roses are very perishable and harvested flowers processed by using the traditional methods, the losses of up to 40 per cent may occur, which directly minimises the marketable volume and lowers the income received (Erbas & Baydar, 2016). Similar evidence in flower post-harvest literature also cites that post-harvest flower losses may be up to about 40% due to poor handling, supporting the fact that physical losses are capable of significantly reducing grower returns (Kumari et al., 2019). Farmers then have low margins as fresh flowers must be sold immediately at the current market prices and they have no time to wait until the prices improve or to negotiate higher prices (Rassem et al., 2022).

Value-added processing, on the other hand, enhances profitability since the turnover on sale of raw commodity, which is time-limited, would be transformed into differentiated products and returns which can increase by two to fifteen times depending on the type of products and the magnitude (Babu et al., 2002). A vivid numerical example is provided by an economic evaluation of the Isparta (Turkey) oil-rose value chain where mean prices are around $1.06/kg of blossoms, $3.52/kg of rose water, $683.80/kg of rose concrete, $1524.76/kg rose absolute and $5505.56/kg rose oil thus demonstrating that value capture is a steeply increasing factor with increasing processing intensity (Gul et al., 2012).

A decision-relevant comparison that is more relevant is the normalisation of processed value to a per kg blossom equivalent since the conversion efficiencies vary widely across products. The productivity standards in the industry used in the same case of Isparta show that approximately 3,500 kg of blossoms are needed to yield 1 kg of rose oil and 350 kg of blossoms are needed to yield 1 kg of rose concrete at the same time using the benchmark product prices, which is a gross blossom-equivalent value of approximately $1.57 per kg of blossom to yield 1 kg of rose oil and $1.95 per kg of blossoms to yield 1 kg of rose concrete. This is an indication of a percentage of

approximately 1.5X (oil) to 1.9X (concrete) gross value per kg, which increased when compared to the situation of sale of blossoms at the spot at approximately 1.06 per kg, given the specified assumptions (Gul et al., 2012). In the case of rose absolute, solvent-processing evidence has an absolute productivity of approximately 249.7 kg fresh flowers to make 1 kg absolute, which, multiplied by the standard level of absolute price, would result in a gross blossom-equivalent value of approximately $6.11 per kg blossoms, i.e. approximately 5.8 times the benchmark level of absolute price (Erbas and Baydar, 2016).

The higher returns are also supported by cost–benefit indicators, at the enterprise level in case production is coupled with processing. As an illustration, a farmer-based study on the cultivation of Damask rose and the production of essential oil by distillation in Punjab (India) has Benefit-Cost Ratio (BCR) = 1.54, Internal rate of return (IRR) = 12.70% and Net present value (NPV) = Rs. 59,842, signifying that the production of oil related products can be economically viable even under farm conditions (Singh and Singh, 2011). In rose-based production systems, Pakistan is also demonstrating some degree of profitability: a case study in Islamabad and Rawalpindi had reported rose production with an annual yield of 1,010 kg/acre, establishment cost of Rs. 0.17 million/acre, total cost of production of Rs. 0.26 million/acre/year and gross and net returns of 0.32 million and 0.06 million/acre/year, respectively, with a BCR of 1.24 (Rasheed et al., 2016). The identical study of Pakistan also indicated that the marketing structure influences the farm profitability as the marketing costs of producers and retailers were Rs. 54.1/kg and Rs. 17.3/kg as well as producer and retailer share in consumer rupee was 77.4 percent and 22.6 percent respectively, and thus the improved market linkages and processing/branding to gain higher margins is important (Rasheed et al., 2016). According to complementary evidence of Punjab (Kasur), cut rose farming can also be attractive, with a reported BCR of 2.07 for cut roses and 1.35 for gladiolus, which suggests that the floriculture sector of Pakistan has a high potential for profitability when production and marketing are done efficiently (Hashmi et al., 2024).

Essential oil is usually the most valuable product per unit mass of the product to be sold, despite low recovery of flowers (Ouzzar et al., 2015). The average yield of rose oil is often reported in very low figures of 0.015 to 0.069 per cent (v/w), which is the reason why so much biomass is needed to produce very little oil and why the product is priced at a high price (Katekar et al., 2022). As an example, the industrial plantation comparison in Bulgaria recorded the essential oil recovery in a similarly narrow range (0.015-0.048%), which is in favour of the realism of very small recovery values in commercial systems (Dobreva et al., 2023). Similarly, in Turkey, hydro-distillation studies showed that the yield was close to 0.042-0.045 per cent based on the medium used in distillation (Kara et al., 2017). In Pakistan, it has been extracted that processing route and genotype can have a significant effect on the recoverable output: concrete oil recovery in Pakistani Damask rose petals was reported at 0.24% on fresh-weight basis in Faisalabad (Khan and Shoaib ur Rehman, 2005) and assessment of Pakistani Damask rose landraces was reported to have an absolute oil content with 0.147% (petal basis), indicating that cultivar/landrace selection can enhance the

processing yield and enhance profitability prospects of local process. It is these yield variances and the fact that the unit value of rose oil has been high in the world market since ancient times that justify the fact that rose oil continues to be profitable in the world despite low recovery and why extraction and processing are economically sensitive (Golmakani and Rezaei, 2008).

Lastly, less specialised capital is frequently needed than the extraction of essential oils to create products like rose water and dried petals, but they add some sense of value addition by increasing their storability and enabling a greater range of consumers to consume them (Rassem et al., 2022). Rose water of approximately 3.52/kg versus blossoms of approximately 1.06/kg in the Isparta benchmark suggests a rough uplift of 3.3x unit price in an otherwise relatively simplistic processing line, which can be especially applicable to the case of smallholders and cooperatives trying to minimise the risk of perishability and gain more revenues (Gul et al., 2012).

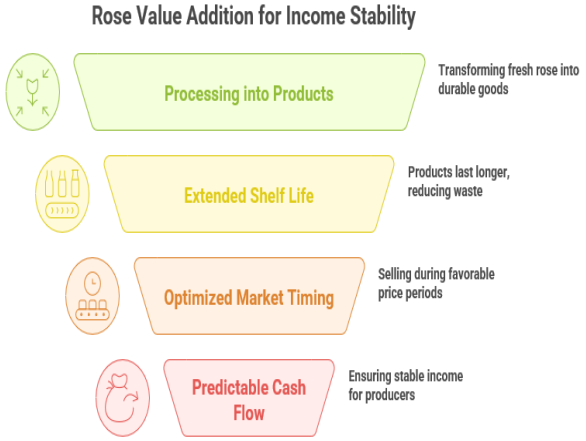
Table 2.Comparative Cost–Benefit Summary of Fresh and Processed Rose Products

Product	Fresh blossoms required	Market price	Blossom-equivalent gross value (USD/kg blossoms)	Relative gain vs fresh flowers	Reference
Fresh rose flowers	1 kg	≈ $1.06/kg	≈ $1.06	Baseline	Gul et al. (2012)
Rose water	1 kg	≈ $3.52/kg	≈ $3.52	~3.3×	Gul et al. (2012)
Rose concrete	~350 kg	≈ $683.80/kg	≈ $1.95	~1.9×	Gul et al. (2012)
Rose absolute	~249.7 kg	≈ $1,524.76/kg	≈ $6.11	~5.8×	Erbas & Baydar (2016)
Rose essential oil	~3,500 kg	≈ $5,505.56/kg	≈ $1.57	~1.5×	Gul et al. (2012); Katekar et al. (2022)

Income Stability and Reduced Wastage Through Value Addition

Preservation of rose petals into value-added products can deal with post-harvest losses to a considerable degree and stabilise revenues (Elik et al., 2019). Under high temperatures, fresh flowers spoil quickly, leading to financial losses in delivery and in the market queues (Sibanda and Workneh, 2020). Conversely, processed foods like rose water, gulkand and dried petals have shelf lives that are between several months and more than a year old, which allows manufacturers to keep stock and sell at pushy prices (Ssepuuya et al., 2016). As an example, to maintain aroma, texture and bioactive components, gulkand production uses standardised petal-to-sugar ratios typically ranging between 1:1 and 1:1.25 (w/w) (Sruthi et al., 2022). The conventional approaches employ the ratio of 1:1.5 to extend the shelf life, whereas health-oriented versions employ 1:0.5 ratios (Roshanak et al., 2016). The effect of these technical parameters on the quality of products and profitability is direct, and it proves that the stability of income is supported by scientific processing practices (Arouna et al., 2021). All in all, value addition minimises risk and maximises market timing and allows rural producers

to have a predictable cash flow (Omoare et al., 2015).



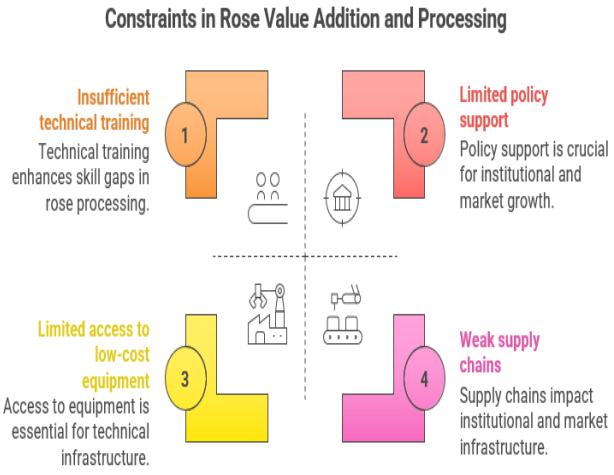
Constraints in Rose Value Addition and Processing

Rosa centifolia value addition has high potential to boost the rural livelihoods, but the growth of the rose-based business is limited by various technical, institutional, and infrastructural barriers (Srivastava et al., 2017). The unavailability of modern extraction technologies is one of the significant technical issues (Bitwell et al., 2023). In most rose-producing regions, particularly in the rural regions of Pakistan, the farmers continue to utilise the old methods of distillation, including simple hydro-distillation in metal drums, where there is no control of temperature and efficiency (Babu et al., 2002). The newer technology, such as steam distillation, solvent extraction, CO 2 extraction and microwave-assisted distillation, is costly and hardly available, leading to low yield and low purity of essential oils, rose water, concretes and absolutes (Sahraoui et al., 2008). Lack of proper post-harvest handling also contributes to the technical issues because rose petals are very perishable and they easily lose aroma compounds when subjected to heat, pressure or delays in processing (Prusky, 2011). In the absence of cold storage, shading or adequate transportation, petals degrade very quickly, resulting in low yields and poor quality of products (Baswal et al., 2020). Moreover, there are numerous growers and small processors whose technical training on the best harvesting time, distillation, filtration, and storage methods, and quality testing is inadequate (Dekka et al., 2023). This knowledge difference lowers the level of efficiency and makes it impossible to produce standardised high-value products (Srivastava et al., 2017).

The rise of the value-addition of rose is also facing significant impediments related to institutional and market (Vahoniya et al., 2018). The high irregularities in the availability and prices of raw materials are generated by weak and uncoordinated supply chains, a low number of producer cooperatives, and inadequate linkages among growers, processors and traders (Hualda et al., 2005). Lack of standardized quality control system also limits competitiveness in the market since most of the processors are not guided by the international quality control standards, like the ISO standard of rose oil or the GMP standard of cosmetic and pharmaceutical products (Fotopoulos and Psomas, 2009). The issue of certification is another obstacle; to obtain organic, halal, fair-trade, or export-grade certifications, financial resources, documentation and technical skills that smallholders tend to lack are required (Noordin et al., 2014). It is characterised by the lack of policy support of floriculture, since farmers can hardly access finance, subsidies, training and government-supported export promotion or branding programs (Kafle et al., 2022). This failure by the institutions to expand rose-based industries and to ensure that value-added activities have not been developed hinders the growth of the rose-

based industries (Kodithuwakku & Rosa, 2002).

Policy and regulatory limitations further intensify the challenges faced by rose-



based value-addition enterprises. Weak enforcement of quality control frameworks and limited adherence to internationally recognised standards such as ISO specifications for rose oil and Good Manufacturing Practices (GMP) for cosmetic and pharmaceutical products reduce competitiveness in high-value markets (Fotopoulos and Psomas, 2009). Certification requirements related to organic, halal, fair-trade and export compliance remain difficult for small-scale processors due to financial, technical and documentation constraints (Noordin et al., 2014). In addition, inadequate policy support, limited access to credit, training opportunities, and export promotion initiatives restrict the scaling of value-added rose enterprises and slow sectoral development (Kafle et al., 2022). As highlighted by Kodithuwakku and Rosa (2002), coordinated institutional frameworks and supportive policies are essential for strengthening agro-based value chains and promoting sustainable growth in rural processing industries.

The sector is also limited by infrastructure factors (Kumar et al., 2020). Processing machines include efficient distillation systems, freeze dryers, filtration systems and packaging machinery, which are expensive and are usually unavailable in rural areas, rendering them inaccessible to small farmers and entrepreneurs (Bitwell et al., 2023). There are a lot of rose-growing regions that have no local processing facilities where fresh petals can be delivered and stored, dried, or distilled (Vahoniya et al., 2018). The lack of cold storage, transport system and post-harvest units such as communities at a local level) makes farmers sell fresh petals in low quantities and at low prices, thus resulting in wastage and low profitability (Prusky, 2011). When combined, these technical, institutional and infrastructural issues make it particularly slow to build a sustainable rose value-addition sector, reducing revenue opportunities of rural populations and limiting the expansion of high-value rose products both in The domestic and foreign market (Kafle et al., 2022).

Export-Oriented Value Chains and Branding Strategies

Transforming the rose industry into a globally competitive sector requires the development of well-structured export-oriented value chains. By focusing on strategic partnerships among growers, processors, exporters and retailers, producers can ensure consistent quality, traceability and timely delivery, which are essential for accessing premium international markets (Noordin et al., 2014). Adoption of modern processing approaches, including advanced distillation techniques and innovative preservation methods, can improve product quality and diversify offerings such as essential oils, hydrosols and value-added products (Bitwell et al., 2023). Establishing strong branding strategies,

encompassing recognised certifications and standards, can enhance credibility, build consumer trust and differentiate products in competitive foreign markets (Fotopoulos & Psomas, 2009). Cooperative models and producer associations provide avenues for shared infrastructure, collective marketing and access to technical guidance, enabling smallholders to participate effectively in high-value supply chains (Hualda et al., 2005). Policy support, including training programs, financial incentives and facilitation of certification, further strengthens these systems and encourages the adoption of best practices in production and processing (Kodithuwakku & Rosa, 2002). By integrating value addition with market-focused strategies and institutional support, rose producers can not only increase profitability but also contribute to rural development, gender empowerment, and the long-term resilience of floriculture-based livelihoods (Kafle et al., 2022).

Conclusion

Roses, especially Rosa centifolia, are an extremely promising crop and can be used as a high-value crop in the floriculture, cosmetics industry, pharmaceuticals industry and organic-based industry. Although the production of fresh flowers is still economical, value-added with the help of the essential oils, rose water, dried petals, gulkand, syrup and herbal formulations is much more profitable. These processed products not only minimize after harvest losses but also stabilise farmers' incomes and also address the increasing local and foreign market demands. Among those, the most profitable ones would be essential oil, gulkand and rose water. Even with this promise, the sector has continued to experience numerous difficulties, such as outdated extraction technologies, poor post-harvest management, ineffective supply chains, ineffective quality management, certification barriers, poor policy, and inadequate infrastructure. Overcoming these barriers is a holistic approach, which includes the following: implementing modern technologies, creating low-cost rural processing facilities, offering capacity-building courses, empowering cooperatives, achieving better quality standards, and establishing easily accessible certification systems. These changes will require the policy and financial support. Pakistan has the potential to exploit the peculiarities of the rose industry to ensure the full economic exploitation of this local environment by improving value chains, sustainable processing methods, etc. The change will not only guarantee long-term profitability but also rural development as well as inclusive economic growth, which will make the country a competitive player in the world market of high-value rose products.

References

Adebayo, I. A., Pam, V. K., Arsad, H., & Samian, M. R. (2020). The global floriculture industry: Status and prospects. In *The* global floriculture industry (pp. 1–14). Apple Academic Press.

Ahmad, I. (2023, May 14). Floriculture holds potential for greater cooperation between Pakistan and China. Daily Times. *https://dailytimes.com.pk/1093104/floriculture-holds-potential-for-greater-cooperation-between-pakistan-and-china/*

Ahmad, I., Dole, J. M., Khan, M. A., Qasim, M., Ahmad, T., & Khan, A. S. (2010). Present status and future prospects of cut rose production in Punjab, Pakistan. HortTechnology, 20(6), 1010-1015.

Akhtar, G., Khan, M. A., Jaskani, M. J., & Ashfaq, M. (2014). Phenotypic plasticity within and among genotypes of *Rosa centifolia* from Pakistan and the USA. Pakistan Journal of Agricultural Sciences, 51(3), 609-616.

Arab News PK. (2024, August 15). For flower farmers in southern Pakistan, life is anything

but a bed of roses. Arab News. https://www.arabnews.pk/node/2567475/pakistan

Arab News PK. (2024, May 10). 'Asia's largest nursery' in Pakistan's Pattoki awaits government support to bolster Gulf exports. Arab News. https://www.arabnews.pk/node/2507961/pakistan

Associated Press of Pakistan. (2025, September 23). Pakistan's new rose variety promises farmers up to Rs1.5m per acre in profits. APP. https://www.app.com.pk/business/pakistans-new-rose-variety-promises-farmers-up-to-rs1-5m-per-acre-in-profits/

Astuti, A. D., Yasir, B., & Alam, G. (2019, October). Comparison of two varieties of *Plectranthus scutellarioides* based on extraction method, phytochemical compound, and cytotoxicity. In Journal of Physics: Conference Series (Vol. 1341, No. 7, p. 072012). IOP Publishing.

Babu, K. G., Singh, B., Joshi, V. P., & Singh, V. (2002). Essential oil composition of Damask rose (*Rosa damascena* Mill.) distilled under different pressures and temperatures. Flavour and Fragrance Journal, 17(2), 136-140.

Basnayake, T. S. K. (2023). Women Entrepreneurs and Poverty Alleviation in Floriculture of Colombo District in Sri Lanka. Colombo Journal of Multi-Disciplinary Research, 7(1-2).

Basu, S., Zandi, P., Cetzal-Ix, W., & Sengupta, R. (2015). The genus Rosa: An aristocrat from the plant family with class, colour, and fragrance. Iran Soc. Environ, 1-9.

Baswal, A. K., Dhaliwal, H. S., Singh, Z., Mahajan, B. V. C., Kalia, A., & Gill, K. S. (2020). Influence of carboxy methylcellulose, chitosan and beeswax coatings on cold storage life and quality of Kinnow mandarin fruit. Scientia Horticulturae, 260, 108887.

Baydar, H., & Baydar, N. G. (2005). The effects of harvest date, fermentation duration and Tween 20 treatment on essential oil content and composition of industrial oil rose (*Rosa damascena* Mill.). Industrial crops and products, 21(2), 251-255.

Bhatta, S., Stevanovic Janezic, T., & Ratti, C. (2020). Freeze-drying of plant-based foods. Foods, 9(1), 87.

Bhavya, S. K., Meena, A., Pranuthi, P., & Bisen, M. (2025). Floriculture under climate change: Modelling impact, adaptive strategies and global trends. International Journal of Advanced Biochemistry Research, 9(10), 109-119.

Bitwell, C., Indra, S. S., Luke, C., & Kakoma, M. K. (2023). A review of modern and conventional extraction techniques and their applications for extracting phytochemicals from plants. Scientific African, 19, e01585.

Bodh, R., Kapoor, P., Katoch, M., Mishra, A., Rana, S., & Bhargava, B. (2024). Postharvest Technology for Commercial Floriculture. In Ornamental Horticulture: Latest Cultivation Practices and Breeding Technologies (pp. 243-258). Singapore: Springer Nature Singapore.

Bravo, J. L. (2019). Distillation Technology: What's Next. Chem Eng Prog, 115(8), 56-60.

Cardoso, I. (2025). Post-Harvest Losses and Their Management in Horticultural Crops: Strategies for Sustainable Food Security. International Journal of Agriculture Sustainable Farming, 1(3), 01-05.

Chandel, A., Thakur, M., Singh, G., Dogra, R., Bajad, A., Soni, V., & Bhargava, B. (2023). Flower regulation in floriculture: an agronomic concept and commercial use. Journal of Plant Growth Regulation, 42(4), 2136-2161.

Chatterjee, R., & Das, K. (2017). Generation of employment for women through value addition in horticultural crops. Journal of Rural and Community Affairs, 2(1), 118-130.

Chetia, I., Vijayakumar, A., & Badwaik, L. S. (2025). Edible flowers' flavour, safety and their utilisation as functional ingredients: A review. Journal of Food Science and Technology, 62(1), 11-23.

Chin, S. K., Siew, E. S., & Soon, W. L. (2015). Drying Characteristics and quality evaluation of kiwi slices under hot air natural convective drying method. International Food Research Journal, 22(6),2250-2256.

Choudhary, S., Petwal, V., & Kumar, C. (2024). Reforming floriculture value addition in roses. THE AGBIZ TODAY, 1(1), 005-007

Dawn. (2021, August 29). Agriculture: The life of Miani's roses. Dawn. https://www.dawn.com/news/1643192

Dekka, S., Paul, A., Vidyalakshmi, R., & Mahendran, R. (2023). Potential processing technologies for utilisation of millets: An updated comprehensive review. Journal of Food Process Engineering, 46(10), e14279.

Dhillon, R., & Moncur, Q. (2023). Small-scale farming: A review of challenges and potential opportunities offered by technological advancements. Sustainability, 15(21), 15478.

Dobreva, A., Nedeva, D., & Mileva, M. (2023). Comparative study of the yield and chemical profile of rose oils and hydrosols obtained by industrial plantations of oil-bearing roses in Bulgaria. Resources, 12(7), 83.

Elik, A., Yanik, D. K., Istanbullu, Y., Guzelsoy, N. A., Yavuz, A., & Gogus, F. (2019). Strategies to reduce post-harvest losses for fruits and vegetables. Strategies, 5(3), 29-39.

Ellermann Flowers. (2025). *The world's biggest rose-growing countries: A guide*. Ellermann Flowers. https://www.ellermann-flowers.com/floral-journal/the-worlds-biggest-rose-growing-countries-a-ellermann-flowers-guide

Erbas, S., & Baydar, H. (2016). Variation in scent compounds of oil-bearing rose (*Rosa damascena* Mill.) produced by headspace solid phase microextraction, hydrodistillation and solvent extraction. Records of Natural Products, 10(5), 555.

Faisal, Z., Saeed, F., Afzaal, M., Akram, N., Shah, Y. A., Islam, F., & Ateeq, H. (2022). Phytochemical profile and food applications of edible flowers: A comprehensive treatise. Journal of Food Processing and Preservation, 46(11), e17061.

Farooq, A., Khan, M. A., Ali, A., & Riaz, A. (2011). Diversity of morphology and oil content of Rosa damascena landraces and related Rosa species from Pakistan. Pakistan Journal of Agricultural Sciences, 48(3), 177-183.

Faust, J. E., & Dole, J. M. (2021). The global cut flower and foliage marketplace. Cut flowers and foliage, 27, 1-47.

Fereidani, B. M., & Uctug, F. G. (2023). Life cycle assessment of rose oil and rose water production: a case study in Iran. International Journal of Environmental Science and Technology, 20(4), 3831-3848.

Fotopoulos, C. B., & Psomas, E. L. (2009). The impact of "soft" and "hard" TQM elements on quality management results. International Journal of Quality & Reliability Management, 26(2), 150-163.

Garden-Robinson, J. (2024). Food preservation: Jellies, jams and spreads. North Dakota State University Extension. https://www.ndsu.edu/agriculture/extension/publications/food-preservation-jellies-jams-and-spreads

Ghasemzadeh, A., Karbalaii, M. T., Jaafar, H. Z., & Rahmat, A. (2018). Phytochemical constituents, antioxidant activity, and antiproliferative properties of black, red, and brown rice bran. Chemistry Central Journal, 12(1), 17.

Gochev, V., Wlcek, K., Buchbauer, G., Stoyanova, A., Dobreva, A., Schmidt, E., & Jirovetz, L. (2008). Comparative evaluation of antimicrobial activity and composition of rose oils from various geographic origins, in particular Bulgarian rose oil. Natural Product Communications, 3(7), 1063-1068.

Golmakani, M. T., & Rezaei, K. (2008). Comparison of microwave-assisted hydrodistillation withthe traditional hydrodistillation method in the extractionof essential oils from Thymus vulgaris L. Food chemistry, 109(4), 925-930.

Gouthami, Y., Chaitra, K., Jige, S. B., Bhavanasi, S. M., Arshad, K., & Ayesha, S. (2024). Rose petals and plates: Exploring the culinary and health wonders of roses. The Agriculture Magazine, 3(9). The Agriculture Publication.

Graana.com. (2024, November 10). Pattoki: The city of flowers in Punjab. Graana. https://www.graana.com/blog/pattoki-the-city-of-flowers-in-punjab/

Grand View Research. (2025). Rose water market size and share: Industry report, 2030. Grand View Research. https://www.grandviewresearch.com/industry-analysis/rose-water-market-report

Gul, M., Kazaz, S., Baydar, H., & Sirikci, B. S. (2015). A study about the technical, economic situation, problems and improvement of oil rose (Rosa damascena Mill.) in Turkey. Journal of Essential Oil Bearing Plants, 18(3), 613-626.

Haban, M., Curna, V. Z., Korczyk-Szabo, J., Magacova, M., & Habanova, M. (2023). essential oil content in flowers from *Rosa centifolia* harvested in different phenophases. *Journal of Hygienic Engineering & Design*, 8(2), 45-53.

Hashmi, M., Komba, B. P., Chattha, M. W. A., Fatima, A., & Hyder, M. F. (2024). Emerging business: Cut-rose and gladiolus production by small-scale florists in Pakistan. Sarhad Journal of Agriculture, 40(2), 570–577.

He, A., & Putra, N. R. (2025). Rose essential oils: Current trends, mapping of extraction techniques, chemical analysis, therapeutic applications, and by-product valorisation. The Canadian Journal of Chemical Engineering, 103(7), 3332-3357.

Hongratanaworakit, T. (2009). Relaxing effect of rose oil on humans. Natural Product Communications, 4(2), 291-296.

Hualda, L. T., Migalbin, L. R., Montiflor, M. O., Manalili, N. M., McGregor, M. J., Murray-Prior, R., ... & Concepcion, S. B. (2005, July). Exploring the antecedents and consequences of trust between vegetable farmers and their preferred trading partners in Southern Mindanao. In the International Symposium on Improving the Performance of Supply Chains in the Transitional Economies 699 (pp. 91-102).

Ikram, S., Khalil, M. A., & Raza, M. Y. (2025). Climate resilient floriculture: Adapting cut flower and foliage production to a changing

climate. In Advances in Global Change Research (Vol. 82). Springer. https://link.springer.com/chapter/10.1007/978-3-032-04141-8_14

IMARC Group. (2024). Global rose oil market report by source, product, distribution channel, application, and region (2025-2033). IMARC Publications. https://www.imarcgroup.com/global-rose-oil-market

Jeanroy, A. (2025). How to dry rose petals. The Spruce. https://www.thespruce.com/dry-rose-petals-for-teas-and-crafts-1762475

Kafle, K., Songsermsawas, T., & Winters, P. (2022). Agricultural value chain development in Nepal: Understanding mechanisms for poverty reduction. Agricultural Economics, 53(3), 356-373.

Kalinowski, J., & Dole, J. M. (2024). Extended storage of cut flowers using sub-zero temperatures. *HortTechnology*, *34*(1), 101-115.

Kara, N., Erbas, S., & Baydar, H. (2017). The effect of seawater used for hydrodistillation on essential oil yield and composition of oil-bearing rose (Rosa damascena Mill.). International Journal of Secondary Metabolite, 4(3), 423-428.

Katekar, V. P., Prayagi, S. V., Mahajan, B. R., & Deshmukh, S. S. (2023). Essential Oils Extraction: A Promising Enterprise for Rural Areas' Sustainable Development. SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology, 15(01), 20-26.

Katekar, V. P., Rao, A. B., & Sardeshpande, V. R. (2022). Review of the rose essential oil extraction by hydrodistillation: An investigation for the optimum operating condition for maximum yield. Sustainable Chemistry and Pharmacy, 29, 100783.

Katsukawa, M., Nakata, R., Koeji, S., Hori, K., Takahashi, S., & Inoue, H. (2011). Citronellol and geraniol, components of rose oil, activate peroxisome proliferator-activated receptor α and γ and suppress cyclooxygenase-2 expression. Bioscience, biotechnology, and biochemistry, 75(5), 1010-1012.

Kayahan, S., Gulbag, F., Kaya, Y., & Altunkanat, H. (2024). Determination of Phenolic, Flavonoid Content and Antioxidant Activity of Oil Rose Products. Horticultural Studies, 41(2), 74-81.

Khan, M. A., & Shoaib-ur-Rehman. (2005). Extraction and analysis of the essential oil of Rosa species. International Journal of Agriculture & Biology, 7(6), 973-974.

Khan, S. A., Shahid, S., Ayaz, A., Alkahtani, J., Elshikh, M. S., & Riaz, T. (2021). Phytomolecules-coated NiO nanoparticles synthesis using abutilon indicum leaf extract: antioxidant, antibacterial, and anticancer activities. International Journal of Nanomedicine, 1757-1773.

Khatib, C. (2024). Aromatherapy: Historical, Phytochemical Insights and Therapeutic Applications. IntechOpen. doi: 10.5772/intechopen.1006954

Kodithuwakku, S. S., & Rosa, P. (2002). The entrepreneurial process and economic success in a constrained environment. Journal of Business Venturing, 17(5), 431-465.

Koushal, S., Sarvade, S. A., Lohar, A., Kaushik, K., Reddy, C. S., & Yampalla, M. (2024). Value addition in floriculture: The potential of flower processing and by-products. International Journal of Advanced Biochemistry Research, 8(11), 523-529.

Kumar, N., Yadav, A., & Singh, J. (2020). Recent trends in herbal cosmetics: A review. Journal of Pharmacognosy and Phytochemistry, 9(3), 1504–1510.

Kumari, M., Swaroop, K., Saha, T. N., & Kumar, R. (2019). Post-harvest handling of cut flowers – a way to minimise market glut. Indian Horticulture, 64(1).

Kwon, E. K., Lee, D. Y., Lee, H., Kim, D. O., Baek, N. I., Kim, Y. E., & Kim, H. Y. (2010). Flavonoids from the buds of Rosa damascena inhibit the activity of 3-hydroxy-3-methylglutaryl-coenzyme A reductase and angiotensin I-converting enzyme. Journal of agricultural and food chemistry, 58(2), 882-886.

Lakshmi, D. V. N., Muthukumar, P., Layek, A., & Nayak, P. K. (2019). Performance analyses of mixed-mode forced convection solar dryer for drying of stevia leaves. Solar Energy, 188, 507-518.

Lucero, M. (2020). Jams' food preservation techniques. Colorado State University Extension. https://sam.extension.colostate.edu/wp-content/uploads/sites/44/2020/05/Jams-Food-Preservation-2020.pdf

Marchioni, I., Pistelli, L., Copetta, A., Dimita, R., Descamps, S., Cambournac, L., & Ruffoni, B. (2021, March). Edible roses are a novel food with healthy value. In IV International Symposium on Woody Ornamentals of the Temperate Zone 1331 (pp. 239-244).

Masyita, A., Sari, R. M., Astuti, A. D., Yasir, B., Rumata, N. R., Emran, T. B., ... & Simal-Gandara, J. (2022). Terpenes and terpenoids as main bioactive compounds of essential oils, their roles in human health and potential

application as natural food preservatives. Food chemistry: X, 13, 100217.

Mebakerlin, M. S., & Chakravorty, S. (2015). Value addition in flowers. In Value Addition of Horticultural Crops: Recent Trends and Future Directions (pp. 83-99). New Delhi: Springer India.

Memon, I. N., Noonari, S., Shahani, I. A., Bhatti, A. M., & Tunio, A. (2015). Performance of rose production in Sindh, Pakistan. Industrial Engineering Letters, 5(7), 1-7. https://www.iiste.org/Journals/index.php/IEL/article/view/23898

Merivaara, A., Zini, J., Koivunotko, E., Valkonen, S., Korhonen, O., Fernandes, F. M., & Yliperttula, M. (2021). Preservation of biomaterials and cells by freeze-drying: Change of paradigm. Journal of Controlled Release, 336, 480-498.

Meziouy, O. E., Youssoufi, M. H., Lafdil, F. Z., Legssyer, A., Bnouham, M., Ziyyat, A., & Mekhfi, H. (2025). The Medicinal Potential of *Rosa centifolia* L.: Integrating Botany, Geographical Distribution, Pharmacology, Ethnobotanical Uses, Phytochemistry, and Toxicology. Chemistry & Biodiversity, *22*(4), e202402491.

Mileva, M., Ilieva, Y., Jovtchev, G., Gateva, S., Zaharieva, M. M., Georgieva, A., ... & Najdenski, H. (2021). Rose flowers-A delicate perfume or a natural healer?. Biomolecules, 11(1), 127.

Miller, J. (2025). Rose water in cuisine: Unlocking its culinary potential. KitchenFiftySeven. https://kitchenfiftyseven.com/what-do-you-use-rose-water-for-in-food/

Ministry of National Food Security & Research. (2023-2024). Fruit, vegetables and condiments statistics of Pakistan. Economic Wing. https://mnfsr.gov.pk/SiteImage/Misc/files/Fruit%20Vegetable%20and%20Condiments%20Statistics%2023-24.pdf

Mohamadi, M., Shamspur, T., & Mostafavi, A. (2013). Comparison of microwave-assisted distillation and conventional hydrodistillation in the essential oil extraction of flowers Rosa damascena Mill. Journal of essential oil research, 25(1), 55-61.

Momotaz, S. N., & Banik, S. (2020). Effects of seasonal variation-driven price disparity on fresh flower business: Evidence from Bangladesh. Journal of business and retail management research, *14*(2), 33-45.

Moody, E. P., Dole, J. M., & Barnes, J. (2014). Refining postharvest handling procedures increased cut rose vase life. HortTechnology, *24*(6), 676-685.

Mordor Intelligence. (2025). Edible flowers market size, share & 2030 trends report. Mordor Intelligence. https://www.mordorintelligence.com/industry-reports/edible-flowers-market

Moreira, M. C. N. D., de Almeida, G. L., Carvalho, E. E. N., Garcia, J. A. D., Nachtigall, A. M., & Vilas Boas, B. M. (2019). Quality parameters, antioxidant activity, and sensory acceptability of mixed jams of rose petals and apple. Journal of Food Processing and Preservation, 43(12), e14272.

Nikolic, M., Ferreira, I. C. F. R., Calhelha, R. C., Fernandes, R. C., Markovic, D., Ciric, T., ... & Sokovic, M. (2013). Chemical composition, antimicrobial, antioxidant and cytotoxic activity of *Rosa centifolia* L. essential oil. International Conference on Natural Products Utilisation: From Plants to Pharmacy Shelf.

Noordin, N., Noor, N. L. M., & Samicho, Z. (2014). Strategic approach to halal certification system: An ecosystem perspective. Procedia-Social and Behavioural Sciences, 121, 79-95.

Observatory of Economic Complexity (OEC). (2023). Cut flowers trade data. Retrieved from: https://oec.world/en/profile/hs/cut-flowers

Omoare, A. M., Fakoya, E. O., & Oyediran, W. O. (2015). Value Addition of Sweet Potato (Ipomoea batatas L. Lam): Impeding Factors on Household Food Security and Vitamin A Deficiency (VAD) in Southwest and Northcentral Nigeria. IOSR Journal of Agriculture and Veterinary Science, 8(9), 06-14.

Ouzzar, M. L., Louaer, W., Zermane, A., & Meniai, A. H. (2015). Comparison of the performances of hydrodistillation and supercritical CO 2 extraction processes for essential oil extraction from rosemary (*Rosmarinus officinalis* L.). Chemical Engineering Transactions, 43, 1129-1134.

Pal, P. K. (2013). Evaluation, genetic diversity, recent development of distillation method, challenges and opportunities of Rosa damascena: A review. Journal of Essential Oil Bearing Plants, 16(1), 1-10.

Parmar, A. B., Patel, P. C., & Vaidya, A. C. (2021). Impact of training on the knowledge level of rose growers about rose production technology. Guj. J. Ext. Edu, *32*(1), 111-114.

Planning Commission of Pakistan & CABI. (2020). Floriculture Cluster Feasibility and Transformation Study. Islamabad: Government of Pakistan. Retrieved from: *https://www.pc.gov.pk/uploads/report/Floriculture_Cluster_Report.pdf*

Priya, M., Singh, D., & Kumar, A. (2021). Value addition through fresh flower arrangements. Agriculture Letters, 2(3-4), 22-28.

Prusky, D. (2011). Reduction of the incidence of postharvest quality losses and prospects. Food security, 3(4), 463-474.

Rani, B., Singh, U., & Maheshwari, R. K. (2013). Natural antioxidants and their intrinsic worth for wellbeing. Glob J Med Res, 1, e13.

Rasheed, M. T., Aujla, K. M., Hussain, A., Qureshi, A. H., & Hassan, T. (2016). Economics and marketing of rose flowers: A case study of Islamabad and Rawalpindi districts, Pakistan (MPRA Paper No. 79707). Munich Personal RePEc Archive. *https://mpra.ub.uni-muenchen.de/79707/*

Rassem, H. H., Nour, A. H., Ali, G. A., Masood, N., Al-Bagawi, A. H., Alanazi, T. Y., ... & Assiri, M. A. (2022). Essential Oil from Hibiscus Flowers through Advanced Microwave-Assisted Hydrodistillation and Conventional Hydrodistillation. Journal of Chemistry, 2022(1), 2000237.

Rhema Flowers. (2025). Flower production by country: Top 11 largest flower-producing countries. Rhema Flowers. *https://rhemaflowers.com/flower-production-by-country-top-largest-producing-countries/*

Roshanak, S., Rahimmalek, M., & Goli, S. A. H. (2016). Evaluation of seven different drying treatments with respect to total flavonoid, phenolic, vitamin C content, chlorophyll, antioxidant activity and colour of green tea (*Camellia sinensis* or *C. assamica*) leaves. Journal of food science and technology, 53(1), 721-729.

Sahraoui, N., Vian, M. A., Bornard, I., Boutekedjiret, C., & Chemat, F. (2008). Improved microwave steam distillation apparatus for isolation of essential oils: Comparison with conventional steam distillation. Journal of Chromatography A, 1210(2), 229-233.

Shabbir, M. K., Nadeem, R., Mukhtar, H., Anwar, F., & Mumtaz, M. W. (2009). Physico-chemical analysis and determination of various chemical constituents of essential oil in *Rosa centifolia*. *Pak. J. Bot*, *41*(2), 615-620.

Shah, A. H., Singh, A., Laishram, N., & Gill, K. (2022). Income Generation through Value Addition of Flower Crops: A Review. International Journal of Environment and Climate Change, *12*(10), 593-613.

Shukla, R. K., Singh, P., Kumar, V., Verma, R. P., Chakravarty, A., & Srivastava, R. K. (2024). Importance and nutritional value with therapeutic properties of a traditional gulkand: A review. Journal of Medicinal and Aromatic Plant Sciences, 46(2), 43-50.

Sibanda, S., & Workneh, T. S. (2020). Potential causes of postharvest losses, low-cost cooling technology for fresh produce farmers in Sub-Saharan Africa. African Journal of Agricultural Research, 16(5), 553-566.

Singh, P. (2025). Fostering value addition in floriculture for economic resilience, community development and market expansion. New Era Agriculture Magazine, 25, 1-6.

Singh, S., & Singh, V. (2011). Economics of the Damask rose plantation in the Punjab State of India. Journal of Non-Timber Forest Products, 18(4), 281-284.

Srivastava, A., Bishnoi, S. K., & Sarkar, P. K. (2017). Value addition in minor fruits of eastern India: an opportunity to generate rural employment. Fruits for Livelihood: Production Technology and Management Practices. Agrobios (India), Jodhpur, India, 395-417.

Srivastava, V., Gangwar, R., Singh, S., & Verma, P. K. (2023). Value Addition of Ornamental Flower Crops. Vigyan Varta, 4(3), 141-144.

Sruthi, N. U., Josna, K., Pandiselvam, R., Kothakota, A., Gavahian, M., & Khaneghah, A. M. (2022). Impacts of cold plasma treatment on physicochemical, functional, bioactive, textural, and sensory attributes of food: A comprehensive review. Food Chemistry, 368, 130809.

Ssepuuya, G., Aringo, R. O., Mukisa, I. M., & Nakimbugwe, D. (2016). Effect of processing, packaging and storage-temperature-based hurdles on the shelf stability of sautéed ready-to-eatRuspolia nitidula. Journal of Insects as Food and Feed, 2(4), 245-254.

TechSci Research. (2023). Rose oil market by share, size and forecast 2028. TechSci Publications.

Thakur, M., Bhatt, V., & Kumar, R. (2019). Effect of shade level and mulch type on growth, yield and essential oil composition of damask rose (Rosa damascena Mill.) under mid-hill conditions of Western Himalayas. PloS one, 14(4), e0214672.

U.S. Food and Drug Administration. (2024). Produce & plant products guidance documents & regulatory information. FDA. *https://www.fda.gov/food/guidance-documents-regulatory-information-topic-food-and-dietary-supplements/produce-plant-products-guidance-documents-regulatory-information*

Usman, M., Ashfaq, M., Taj, S., & Abid, M. (2014). An economic analysis of cut-rose flowers in Punjab, Pakistan. JAPS: Journal of Animal & Plant Sciences, *24*(2).

Vahoniya, D., Panigrahy, S. R., Patel, D., & Patel, J. (2018). Status of floriculture in India: With special focus on marketing. International Journal of Pure and Applied Biosciences, 6(2), 1431-1438.

Vo, T. P., Pham, T. V., Tran, T. N. H., Vo, L. T. V., Vu, T. T., Pham, N. D., & Nguyen, D. Q. (2023). Ultrasonic-assisted and microwave-assisted extraction of phenolics and terpenoids from Abelmoschus sagittifolius (Kurz) Merr roots using natural deep eutectic solvents. ACS omega, 8(32), 29704-29716.

Wang, H. (2024). Beneficial medicinal effects and material applications of the rose. Heliyon, 10(1).

World Bank. (2023). Fresh cut flowers and buds exports by country (HS 060310). World Integrated Trade Solution (WITS). *https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2023/tradeflow/Exports/partner/WLD/product/060310*

Wos, K., & Kiełtyka.D. A. (2021). Hydrolate rose (Rosa Flower Water) is an ingredient in cosmetics for sensitive skin. Archives of Physiotherapy and Global Research, 25(1), 53-67.

Yang, Z., Cao, Z., Yu, C., Feng, T., Yao, L., Song, S., ... & Wang, H. (2024). Impact of using high-pressure homogenization on the chemical profile, quality, stability and bioactivity of the hydrosol obtained from rose flower. Food and Bioproducts Processing, 144, 22-31.

Zhao, C. Y., Xue, J., Cai, X. D., Guo, J., Li, B., & Wu, S. (2016). Assessment of the key aroma compounds in rose-based products. journal of food and drug analysis, 24(3), 471-476.

Zhao, X., Jiang, Y., Qiao, M., Lin, F., & Miao, B. (2025). Recent Advances in Bioactive Compounds, Health Functions, and Utilisation of Rose (Rosa spp.). Molecules, 30(19), 3869. Arouna, A., Michler, J. D., & Lokossou, J. C. (2021). Contract farming and rural transformation: Evidence from a field experiment in Benin. Journal of Development Economics, 151, 102626.

Zion Market Research. (2025). Rose oil market size, share, and growth report. Zion Market Research. *https://www.zionmarketresearch.com/report/rose-oil-market*