

Enhancing the Value Chain of Marigold: Cultivation, Challenges, and Diverse Applications

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ABSTRACT

Marigold (*Tagetes* spp.) is a versatile plant renowned for its vibrant flowers and multifaceted applications across various industries. This review explores the value addition of marigold, emphasizing their economic and therapeutic potential. The phytochemical composition of marigold, rich in carotenoids, flavonoids, and essential oils, underpins its diverse applications in pharmaceuticals, cosmetics, and the food industry. Marigold extracts exhibit significant anti-inflammatory, antioxidant, and antimicrobial properties, making them valuable in medicinal and cosmetic formulations. In agriculture, marigold serves as a natural pest repellent and soil conditioner. Additionally, the use of marigold in food products as a natural colorant and flavor enhancer is gaining traction.

Keywords: Marigold, Therapeutic Potential, phytochemical composition, inflammatory, antioxidant, and antimicrobial properties

Introduction

Marigold, a cherished member of the *Tagetes* genus, holds a prominent place in global floriculture and agriculture. Known for its vibrant blooms and diverse species, marigold captivates with hues ranging from sunny yellows and oranges to deeper reds and mahoganies. Its appeal extends far beyond its aesthetic qualities, encompassing a spectrum of uses from ornamental gardening to medicinal and industrial applications [1]. In floriculture, marigolds are prized for their resilience and ease of cultivation, making them a favorite among gardeners and commercial growers alike. Their ability to thrive in various climates and soil conditions has contributed to their widespread popularity in landscaping and floral arrangements worldwide. Marigolds are not just visually appealing but also symbolic in many cultures, often associated with celebrations, rituals, and festivals [2].

Beyond their ornamental value, marigolds boast a rich history of medicinal and industrial uses. The flowers are sources of essential oils and natural dyes, utilized in perfumery, cosmetics, and textile industries. Their extracts are valued for their antimicrobial, anti-inflammatory, and antioxidant properties, enhancing their role in traditional medicine and modern pharmaceuticals, marigold cultivation supports economic livelihoods in rural communities and promotes sustainable agricultural practices. Their natural pest-repellent properties reduce reliance on chemical pesticides, fostering healthier ecosystems and contributing to biodiversity conservation [4]. In essence, marigold stands as a testament to the synergy between beauty and utility in horticulture, embodying both cultural significance and practical versatility across diverse industries [5].

Marigolds are widely grown throughout India, occupying a

prominent position among flower crops. Their flowers are commonly used for decoration, garland-making, and landscape gardening as bedding and potted plants. As one of the most important annual flower crops in India, marigolds are extensively utilized in religious and social ceremonies. There are 33 species within the *Tagetes* genus, with *Tagetes erecta* (African marigold) and *Tagetes patula* (French marigold) being the most prevalent. Given the significant role marigolds play in Indian flower culture, farmers must understand the plant's lifecycle and implement effective cultivation practices to ensure high-quality, profitable yields [6]. In addition to their ornamental value, marigolds offer substantial benefits, including applications in health sectors and crop protection. They produce compounds such as α -terthienyl, which have allelopathic effects on plant-parasitic nematodes. Efficient marketing channels and networks are essential for the successful commercialization of marigolds, ensuring that cultivators receive a fair share of consumer costs through proper marketing information and implementation [7].

African Marigold: Varieties of this type grow tall, reaching up to 90 cm. The flowers are large and come in a range of colors, including lemon, yellow, golden yellow, orange, and bright yellow. These are long-duration varieties and include types such as Giant Double African Orange, Crown of Gold, Giant Double African Yellow, Chrysanthemum Charm, Golden Age, and Cracker Jack.

French Marigold: French Marigold (*Tagetes patula*) is an early-maturing, dwarf variety known for its compact growth and vibrant flowers. These blooms come in shades of yellow, orange, golden yellow, rusty red, and mahogany.

Popular in gardens and containers, French Marigolds are prized for their ease of cultivation and decorative appeal in borders and beds.

Pusa Basanti Gainda: Pusa Basanti Gainda is a long-duration marigold variety known for its tall stature of approximately 58.80 cm and dark green foliage. It produces double, carnation-type flowers in a striking sulphur yellow color. This variety is favored for its robust growth and ornamental value in gardens and floral arrangements.

Pusa Narangi Gainda: This variety takes 125-136 days to flower. The plants are tall, reaching a height of 73.30 cm, with dark green leaves. The flowers are orange, compact, double-layered, and carnation-like, yielding an average of 140 quintals per acre of fresh flowers.

Harvesting and Post-Harvest Processing: Depending on the variety, marigolds are ready for harvest within 2 to 2.5 months. French marigolds are ready in about 1.5 months, while African marigolds take approximately 2 months. Flowers should be harvested when they reach full size, preferably in the morning or evening. Irrigating the field before plucking helps maintain flower quality for a longer period.

Tagetes Oil: Marigold flowers produce a strongly aromatic oil known as Tagetes oil, which is used in the cosmetics and perfume industries. The oil extracted from fresh flowers can have a deforming effect on the spinal marrow and is also used as an antiseptic.

Yield: The yield of marigold flowers varies depending on the cultivar and cultivation practices, such as planting, spacing, and fertilization. For French marigolds, the number of flowers ranges from 6 to 8 million per hectare, with flower weights ranging from 8 to 12 tonnes per hectare. For African marigolds, the number of flowers ranges from 1.5 to 2.5 million per hectare, with flower weights ranging from 11 to 18 tonnes per hectare.

Postharvest Technology

Postharvest technology of marigold focuses on preserving the quality and extending the shelf life of harvested flowers. After harvesting, marigold flowers are typically dried under shade for 2-3 days to reduce moisture content and prevent decay. Proper drying helps maintain color, texture, and overall aesthetic appeal. The seeds are separated by gently hammering the flowers, followed by winnowing to remove straw and debris.

Postharvest handling also includes cleaning and grading the seeds before packing them into poly or cloth bags. Storage in cool, dry conditions is crucial to prevent mold growth and maintain seed viability. Regular monitoring of moisture content ensures the seeds remain free from excess moisture, which can lead to fungal infections.

Overall, effective postharvest practices in marigold cultivation involve meticulous handling, proper drying techniques, careful seed separation, grading, and storage management to ensure a high-quality product ready for market distribution.

Postharvest processing, grading, packing and storage

Postharvest processing of marigold involves careful drying of flowers under shade to preserve quality, followed by grading to ensure uniformity in size and color. The flowers are then packed in appropriate materials such as polyethylene or cardboard

boxes to protect them during transportation and storage. Storage conditions are crucial, with cool temperatures and controlled humidity levels maintained to prolong shelf life. Proper postharvest management ensures that marigold flowers retain their freshness and quality, meeting market demands effectively [8].

Extraction of Oil and Quality Control

Extraction of oil from marigold is primarily achieved through steam distillation of its flowers, which are rich in essential oils like linalool, limonene, and linalyl acetate. Quality control in oil extraction involves ensuring optimal conditions during distillation to preserve the aromatic compounds and therapeutic properties of the oil. Factors such as temperature, pressure, and duration of distillation play critical roles in determining the oil's purity and potency. After extraction, the oil undergoes rigorous testing for chemical composition, purity, and efficacy to meet industry standards and regulatory requirements. Quality control measures also include testing for contaminants and ensuring that the oil is free from impurities that could affect its aroma or therapeutic benefits. Proper handling and storage post-extraction are essential to maintain the oil's quality over time, ensuring it remains suitable for various applications in cosmetics, perfumery, and pharmaceuticals. (6).

Marketing, Distribution and Transportation

The crop is in high demand for decorations, garlands, and religious functions. It can be marketed in major cities, supplying hotels, institutions, and other venues. For distributing garlands, the flowers should be packed in bamboo baskets covered with damp muslin cloth to preserve their freshness.

Pinching

Removing the apical portion of the shoot early results in the emergence of numerous axillary shoots, leading to well-shaped, bushy plants that bear a greater number of uniform flowers. Removing shoot apices 40 days after transplanting enhances flower yield.

Important Tips and Best Practices for Crop Cultivation

- Always use disease-free planting material.
- Timely weed management should be conducted.
- Flowers should be harvested at the proper time and stage.

For distribution to the market, flowers should be packed in bamboo baskets covered with moist muslin cloth.

Alternative Uses or Value Addition of marigold

Flowers decoration, garland, perfumery industry, bedding purpose, medicinal and cosmetic industry, colour making, etc.



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Postharvest management and value addition in marigold

Marigolds were discovered in the early 16th century and introduced to Europe and North Africa in the late 16th century, where they quickly became popular in gardens. The genus name, *Tagetes*, is derived from a mythical Etruscan goddess. The wild French marigold (*Tagetes patula*) is an 18-inch tall shrub with fragrant, feathery leaves and daisy-like flowers. The African wild marigold stands 4-5 feet tall with 2-4 inch flowers that range in color from yellow to deep orange. Due to its resilience and ease of cultivation, marigolds have gained significant attention from flower growers.

In India, marigold production reached approximately 1,000 metric tonnes in 2016-17, with a planting area of 68,330 hectares (DAC & FW). Madhya Pradesh is renowned as a major marigold-producing region. Both yellow and orange marigolds are widely used in traditional Indian wedding decorations and are integral to major Hindu festivals such as Diwali and Dussehra. Bright orange blossoms are hung for auspicious reasons, and the flowers are used in various rituals. Marigolds have been a vital part of Indian celebrations for around 350 years. The spiritual significance of marigold flowers extends beyond Hinduism, being recognized in Christianity as well [9].

Enhancement of Marigold Floral Quality Parameters:

1. Flower (dimensions, state, ripeness, form, durability, hue, texture, appearance)
2. Stem (dimensions, form, and resilience)
3. Defect-free and ailment-free; it is crucial to execute proper harvesting and care of flowers post-harvesting to extend vase life and ensure a premium product.

Factors Influencing Post-Harvest Longevity and Quality of Flowers:

1. Harvesting stage/ripeness
2. Temperature
3. Humidity levels
4. Storage conditions
5. Packaging
6. Pathogens

Harvesting

Proper irrigation should be followed before harvesting flowers for proper longevity and quality flowers. Harvest during cool hours of the day

Grading and bunching

Store under the relative humidity of 84 per cent to 90 per cent and storage temperature of 4° C gives maximum shelf life and quality to room temperature marigold flowers.

Post-harvest handling of marigold

Postharvest handling of marigold flowers is critical to preserving their quality, extending shelf life, and ensuring they reach consumers in optimal condition. The process begins immediately after harvesting, focusing on minimizing physical damage, controlling moisture levels, and maintaining overall freshness.

Drying and Conditioning: Marigold flowers are typically dried immediately after harvest to reduce moisture content and prevent microbial growth. This is usually done under shade to protect the flowers from direct sunlight, which can fade their vibrant colors.

Proper drying helps retain the flowers' shape, color intensity, and fragrance. Flowers are spread out in a single layer on clean, dry surfaces and turned regularly to ensure even drying.

Cleaning and Grading: Once dried, the flowers undergo cleaning and grading processes. Cleaning involves removing any debris, damaged petals, or other impurities. Grading ensures uniformity in size, shape, and color, which is crucial for marketability. This process also involves removing immature or defective flowers to maintain product quality standards.

Packaging and Storage: After cleaning and grading, marigold flowers are packed in suitable containers to protect them during transport and storage. Common packaging materials include cardboard boxes lined with polyethylene or cloth bags. Proper packaging helps maintain the flowers' freshness and prevents physical damage during handling.

Storage Conditions: Storage conditions play a vital role in preserving marigold flowers. They should be stored in cool, dry environments to slow down respiration rates and minimize water loss. High humidity can lead to fungal growth, so maintaining optimal humidity levels is crucial. Regular monitoring of storage conditions ensures that any deviations can be promptly addressed to prevent quality deterioration.

Transportation and Distribution: Careful transportation is essential to avoid physical damage and maintain freshness. Marigold flowers are often transported in refrigerated trucks or insulated containers to ensure they arrive at their destination in prime condition. Efficient distribution networks ensure prompt delivery to markets, florists, and other retail outlets.

How is post-harvest loss caused in marigolds?

Due to a lack of adequate facilities such as efficient transportation, communication, parking, and advancements in post-harvest technology, the quality of marigold flowers often deteriorates, resulting in increased postharvest loss. The lack of adequate infrastructure further exacerbates this issue. To mitigate these problems, several measures can be implemented:

1. **Temperature Control:** Maintaining an appropriate temperature after harvesting is crucial to extending the flower's life.
2. **Ventilation:** Ensuring proper ventilation is essential.
3. **Humidity Regulation:** Regulating relative humidity (Rh) helps control the respiration rate of the flowers.
4. **Frost Protection:** Protecting buds from excessive frost after harvesting is necessary to preserve their quality.

Packaging Materials: Various packaging materials are used, including polyethylene, cardboard boxes, cellophane, and newspapers. The ideal packaging consists of cardboard boxes lined with polyethylene to ensure the best preservation of the flowers. (7).

Value addition of Marigold

Value addition is primarily understood as the difference between the total cost involved in producing or acquiring an asset and the revenue generated from its sale. Value-adding activities largely involve reallocating resources.

Accordingly, this chapter proceeds to evaluate the revenue at various levels obtained by flower producers, ultimately estimating the increase in marigold value. Larger marigold garlands are more advantageous compared to smaller flower arrangements [8] Marigold (*Tagetes spp.*) offers significant value addition across various industries due to its versatile properties and vibrant appeal. In agriculture, marigold cultivation is not only profitable but also environmentally beneficial, contributing to pest control and soil health. Beyond its agronomic benefits, marigold's value extends into several key sectors:

Food Industry

Marigold serves as a natural food colorant, providing vibrant yellow and orange hues to cheeses, butters, and other food products. Its extracts, rich in carotenoids like lutein and zeaxanthin, are used to enhance the visual appeal of foods and beverages. The petals are also used in salads, teas, and as a culinary garnish due to their mild, tangy flavor [9].

Pharmaceutical and Medicinal Uses

Marigold extracts are prized for their medicinal properties. They exhibit anti-inflammatory, antibacterial, and antioxidant effects, making them valuable in herbal remedies, ointments, and medicinal teas. Marigold preparations are used to treat skin conditions, promote wound healing, and alleviate inflammation in traditional medicine practices.

Cosmetics and Perfumes

Marigold oil, extracted from its flowers, is used in cosmetics and perfumery for its aromatic properties. It adds a distinctive floral note and is sought after for its natural fragrance. The oil is also utilized in skincare products for its soothing and antiseptic qualities [10].

Textile Industry:

Marigold extracts serve as natural dyes for textiles, offering hues ranging from yellow to orange. These natural dyes are favored for their sustainability and biodegradability, aligning with the growing demand for eco-friendly textile production practices.

Cultural and Decorative Uses

Marigold's bright and cheerful flowers are popular in floral arrangements, garlands, and religious ceremonies worldwide. They symbolize prosperity, happiness, and are integral to festivals like Dia de los Muertos in Mexico and Diwali in India. (9)

Economic and Environmental Impact

The cultivation of marigold not only supports rural livelihoods but also contributes to biodiversity conservation and sustainable agriculture practices. Its pest-repellent properties reduce the need for chemical pesticides, promoting healthier ecosystems and reducing environmental impact.

Marketing

Marketing marigold in India, especially within the realm of floriculture, involves strategic planning and execution to meet diverse consumer demands and seasonal trends. Marigold holds significant cultural and religious value in India, prominently featured in festivals, weddings, and religious ceremonies. This cultural significance drives its demand throughout the year, with peak seasons during festivals like Diwali, Dussehra, and weddings.

Floriculture in India focuses on both domestic and export markets. Domestically, marigold is marketed extensively through local markets, flower mandis (markets), and direct sales to retailers and consumers. The supply chain involves farmers, wholesalers, retailers, and decorators, ensuring a steady flow of fresh flowers to meet demand. In recent years, there has been an increasing trend towards value-added products using marigold, such as garlands, bouquets, and floral decorations. These products cater not only to traditional uses but also to newer trends in event management and décor. Challenges in marigold marketing include post-harvest handling, storage, and transportation issues that affect quality and shelf life. Addressing these challenges requires improved infrastructure, better packaging techniques, and efficient logistics. Moreover, exploring international markets presents opportunities for Indian floriculture to expand its reach and capitalize on global demand for unique floral varieties and traditional Indian flowers like marigold.

Marketing Patterns and Value Addition: Marketing is crucial for the successful sale of marigolds. In Yamuna Nagar district of Haryana, there is no dedicated flower market ("phoolmandi"), so farmers sell marigolds through retailers. Larger garlands are more profitable than smaller ones. Marigolds are adaptable and easy to grow, used both as cut flowers and in making cosmetics and perfumes. Producers typically sell their marigolds in the Yamunanagar flower market, with some growers assembling 2-3 percent of their produce themselves to secure better prices. Small producers often sell within their villages to avoid market deceptions.

Wholesalers: Marigold producers sell their flowers through three main channels:

1. Directly to consumers.
2. Through retailers.
3. To wholesalers, who then sell to retailers, reaching the consumer last.

A competitive market system requires sellers and buyers to be well-informed about flower supply and demand. Wholesale markets play a vital role in efficiently collecting, recording, and disseminating data, improving investment decisions, resource allocation, and flower production and distribution.

Retailers: Retailers purchase marigold flowers from farmers and distribute them in the market. Various private shopkeepers sell marigolds, and retailers also buy from phoolmandis. Marigolds are especially in demand for decorations in weddings and festivals like Gowri-Ganesh, Navratri, and Diwali, which drives up prices. Marigold flowers are globally sought after for their natural anti-inflammatory and anticancer properties, further increasing their demand.

Conclusion

The value-added applications of marigold underscore its dual role in enhancing economic prosperity and therapeutic benefits. From its vibrant blooms enriching landscapes and cultural celebrations to its versatile uses in pharmaceuticals, cosmetics, and textiles, marigold proves its worth as a valuable commodity in various industries. The economic significance of marigold cultivation is evident in its ability to generate income for farmers and support local economies, particularly in rural areas. Simultaneously, its medicinal properties, including antimicrobial and anti-inflammatory effects, highlight its

potential to enhance human health and well-being. As consumer demand grows for sustainable and natural products, marigold's appeal as a source of natural dyes, essential oils, and herbal remedies continues to expand. This reinforces its relevance in the global market and underscores its role in promoting environmentally friendly practices. Moving forward, continued research and innovation in marigold cultivation and processing will further unlock its economic and therapeutic potential, benefiting both industry stakeholders and consumers seeking natural and eco-friendly alternatives. Thus, marigold stands as a testament to the harmonious integration of economic viability and therapeutic efficacy in botanical resources.

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