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Commercial Application of Lutein: Marigold Flower Pigment

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ABSTRACT

In the Asteraceae family, the genus *Tagetes* contains annual and perennial herbaceous plants. This Asteraceae species is native to Mexico and other parts of warmer North America, and it has naturalized elsewhere in the tropics and subtropics. Pigments are chemical substances that absorb light in the visible spectrum and plant pigments are also known as bioactive chemicals, natural colorants and due to their possible health benefits, which have enhanced their economic demand in the current setting. Marigold flowers (*Tagetes*) are rich in lutein, a carotenoid pigment that ranges in hue from yellow to orange-red. Lutein is a carotenoid pigment that is yellow and belongs to the xanthophyll family. Following solvent extraction and solvent removal from dried marigold flowers, oleoresin is obtained, which is refined to create a mixture of lute in and xanthophylls suitable for human consumption as a food additive or dietary supplement. The use of lute in as a good antioxidant has expanded into the nutritional, poultry industry, dyeing industry, and pharmaceutical industries.

Key words: *Dyeing, Lutein, Marigold, Pharmaceutical, Pigment, Poultry*

Introduction

Pigments are chemical substances that absorb light in the visible spectrum (Delgado *et al.,* 2000). Pigments are found in every organism and are responsible for the colors seen around the world; the plant is the primary producer (Shetty *et al.,* 2017). Plant pigments are also known as bioactive chemicals, natural colorants and due to their possible health benefits, which have enhanced their economic demand in the current setting (Fernandez *et al.*, 2020). Plant pigments have a role in metabolic and energy-generating processes, as well as protecting other biomolecules from oxidative stress and UV radiation (Sakuta, 2014).

The Asteraceae family contains 1,600 genera and 23,000 species, which range from herbs to shrubs to climbers to medicinal plants and the genus *Tagetes* contains annual and perennial herbaceous plants. This Asteraceae species is native to Mexico and other parts of warmer North America, and it has naturalized elsewhere in the tropics and subtropics. Marigold has picked the interest of flower producers due to its abundant blooming, rapid time to create commercial blooms, form, size, and good keeping quality. It's one of India's most popular traditional flowers, and it's used in a variety of ways for religious and social events (Deepa and Patil, 2016). Marigold blossoms come in a variety of colors that endure a long time, and the flowers can be cut and preserved for a long time, as well as the complete plant. According to the National Horticulture Board, the fol-

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lowing areas are under floriculture crops in India: In 2017-18, loose flower production was at 3, 24,000 hectares, with a total of 19,62, 000 MT. Floriculture area is reduced to 3, 13,000 hectares in 2018-19, with an expected production of 20, 59,000 MT. Cut flower production was 8,17,000 MT in 2017-18, with an expected production of 8,07,000 MT in 2018-19. In India, roughly 110,000 hectares of land are dedicated to flower cultivation. During the 2018-19 season, the overall area and output of flowers were around 3, 39,386 ha, with a total production of 19, 91,381 MT. In 2018-2019, India's total floriculture exports totaled Rs. 571.38 crores/81.94 USD million (Lohar *et al.,* 2018).

Lutein is the most abundant carotenoid, accounting for almost 90% of all carotenoids in ester forms, while zeaxanthin makes up just around 5% of total carotenoids in ester forms (Fuad *et al.,* 2020). Lutein and zeaxanthin are known as macular carotenoids because they concentrate in the macula region, along with meso-zeaxanthin (Krinsky *et al.,* 2003). Several studies have shown that lutein and zeaxanthin are prevalent in human milk, serum, and tissues, supporting their role in human health (Bernstein *et al.,* 2016). Marigold flowers (Tagetes) are rich in lutein, a carotenoid pigment that ranges in hue from yellow to orange-red. Lutein is a carotenoid pigment that is yellow and belongs to the xanthophyll family. Lutein is being more commonly used as an active ingredient in food and textile coloring.

Lutein Extraction from Marigold

Following solvent extraction and solvent removal from dried marigold flowers, oleoresin is obtained, which is refined to create a mixture of lutein and xanthophylls suitable for human consumption as a food additive or dietary supplement (Breithaupt and Schlatter, 2005). In the presence of marigold petal powder (MPP, 18%) and water, the pigment extraction of marigold can also be done using nanotechnology; the combination of sucrose monopalmitate: The maximum efficacy was seen in 1-propanol (1:5), i.e. 42 % (Jivan and Abbasi, 2019). In canola oil, lutein esters can be extracted without solvents from marigold petals to obtain lutein pigment. Extraction with oil yielded roughly twice as much as acetone and nearly as much as n-hexane, showing that it can reduce process costs while improving product safety (Indrawati *et al.,* 2019). For extracting lutein diester from the marigold meal, lutein diester and lipophilic material are dissolved in supercritical fluid carbon dioxide at specific temperatures and pressures, followed by the separation of a high-quality lutein diester extract (Rao and Reddy, 2003).

Commercial Application of Marigold Pigment

Pharmaceutical Use

As the nutraceutical industry is growing with the aid of the day, extra pre-clinical and scientific studies on lutein formulations are wanted so that lutein, which has an extensive variety of applications inside the remedy of illnesses, may be included as a commonplace intervention for the eye- health issues (Madaan *et al.,* 2017). Lutein-containing eye drops are able to reduce conditions associated with Dry Eye Syndrome (DES) by decreasing inflammation on the ocular surface and are not ingested (Chen *et al.,* 2021). Lutein is also beneficial for other tissues, such as the brain, where its role in improving cognitive function has been proven (Buscemi *et al.,* 2018). Lutein supplemented with carotenoids increased the level of macular pigment optical density (MPOD) substantially and mesozeaxanthin supplementation increased MPOD more than supplementing with no carotenoids. Furthermore, it has been shown that the xanthophyll carotenoid concentration in the blood is positively related to MPOD during pregnancy (Le Ma *et al.,* 2016). The levels of lutein and zeaxanthin in eye tissues are negatively correlated with age-related degenerative diseases such as macular degeneration (AMD) and cataracts, according to epidemiological studies (Koushan *et al.,* 2013). Most animal studies and clinical trials have shown that lutein helps prevent various diseases from developing and progressing. Additional data have also emerged supporting lutein's potential function in the treatment of other eye illnesses such as Retinopathy of Prematurity (ROP), myopia, and cataract (Li *et al.,* 2020).

Food Additive

Marigolds are available all year, reaching their peak in the winter months and the fall months, and are easy to grow due to few pests and diseases.Food coloring comes from lutein, which is one of the richest sources of, and its coloring and antioxidant qualities are used in the creation of functional and healthy foods (Behl *et al.,* 2021). Several factors have led to lutein's inclusion as a functional food ingredi-

ent, including its ability to mix well with other ingredients, as well as its vulnerability to certain environmental variables, such as high temperatures, light, and oxygen (Becerra *et al.,* 2019). The lutein extracted from marigold (*Tagetes erecta* L.) can also be used to produce food supplements, and the manufacturers of lutein-containing supplements must carefully select and blend the lutein concentrates to obtain the best quality lutein for their product. The lutein concentrates from the manufacturers based in India are thought to be of the best quality (Šivel *et al.,* 2014). *T. erecta* provides a lemon-yellowcolor shade that, when added to food goods, boosted the attractiveness of the food by giving it a lemon yellow tint (Hina *et al.,* 2018). Marigold powder's processing in a food system may open up new possibilities for the food industry to develop functional food products that rely on lutein fortification without sacrificing quality (Nam *et al.,* 2021). Due to the lutein content, marigold flower petals (*T. erecta*) could be used as both a culinary color and a vitamin supplement. The antioxidant qualities of lutein make marigold flowers even more appealing as a functional food ingredient, indicating that lutein has a lot of promise (Alotaibi *et al.,* 2021). Microbiological study of the extracted color in crude form and sweets colored with *T. erecta* color revealed that the color, both in crude form and in candies, had antibiotic activity rather than promoting microbial development. The color extracted from marigold was found to be safe for ingestion when a lethal dose of 1000ml of extracted color was given to rabbits (Hina *et al.,* 2018).

Animal Feed Industry

Marigold Flower Extract (Lutein) is a natural source of carotenoids used as a feed additive in poultry diets. Carotenoids can be found in chicken feed components and supplementing feed combinations with synthetic or natural carotenoids can boost their concentration even more. It can be said that the knowledge on carotenoids' utilization in broiler chickens and laying hens can be either synthetic or natural carotenoids generated from plants (Yabuzaki, 2017). There are numerous alternatives to synthetic carotenoids that can be used in chicken diets and satisfy consumer demand for poultry products that are devoid of harmful side effects, where lutein from marigolds can be the best (Marounek and Pebriansyah, 2018). Incorporating marigold flower extract into hens' diets does not affect egg quality, but it helps to enhance yolk color darkness and carotenoid concentration. As a result, marigold flower extract is a good substitute for synthetic carotenoids sold in stores (Skøivan *et al.,* 2015). Lutein, an extract of Marigold flowers, has been included in the diet of Coturnix coturnix japonica laying quails to reduce egg cholesterol and improve egg quality in terms of yolk color and production (Mirzah and Djulard, 2016). The natural occurrence and oxidative vulnerability of *Tagetes* extracts make them a good source of lutein and zeaxanthin for chicken feed, but it won't have an effect on their concentration in the environment.

Carotenoids and fat-soluble vitamins are recognized as tracer molecules in dairy products, together with specific Fatty acids (FA), suggesting good milk quality and animal-feeding management (Martin *et al.,* 2005). Lutein supplementation improves milk output, lactose content, and fat content in the milkand milk quality in nursing cows by increasing their antioxidant capacity and preventing illnesses (Calderón *et al.,* 2007). When cows eat diets that are deficient in lutein, the milk is likely to be deficient in lutein as well. It's possible that if a high amount of lutein is consumed for a long time, comparatively significant levels of lutein will be absorbed into the blood, resulting in a larger level of lutein in the milk (Xu *et al.,* 2014).

As Dyeing Agent

Plants are essential to the production of dyes. A large number of countries practice herbal dyeing as an effective method of dyeing handicrafts, while synthetic dyes are used for industrial dyeing. Nowadays with the worldwide challenge of using green and biodegradable materials, the urge of using herbal dyes withinside the fabric industry has been increased. A marigold plant extract may be considered as a high-quality antibacterial and antimicrobial dye for textiles. The main challenge facing the incorporation of plant-based dyes in modern textile processes has been about maintaining the color strength and fastness of natural colored materials (Adeel *et al.,* 2016). Marigold extracts (lutein) can be used to dye cotton clothing, and experiments have shown that washing and drying in the shadow/sunlight have little effect on surface concealment. It has been discovered that the marigold extract concentration may be utilized on cotton materials. (Harlapur *et al.,* 2020). The fabric dyed with marigold extract has been discovered to have a high level of resistance to bacterial attack. It has been found that marigold blooms' coloring power has a phenomenal

hotspot for material coloring against microorganisms, also the trash is biodegradable and makes great manure (Harlapur and Harlapur, 2021).

Lutein Market Overview

The global lutein market is expected to grow by 5.4 percent from 2019 to 2024. This market is primarily driven by increased demand for diet supplements, especially for eye care, because they work as antioxidants and support the eye's function to maintain healthy eyesight and other health disorders including diabetes and heart disease. In addition, favoring government initiatives helps market growth (Anonymous, 2020). The global lutein market was anticipated to be worth USD 317.66 million in 2020, rising to USD 356.70 million in 2021, with a CAGR of 12.72 percent to USD 734.60 million by 2027 (Anonymous, 2022). Lutein supplements, for example, are listed as medicines on the Australian Register of Therapeutic Goods, meaning that they are safe to take, yet they are allowed as nutritive components in baby and follow-on formulae in New Zealand. Kemin Industries received a patent in 2016 for the role of their lutein product FloraGLO & ZeaONE Zeaxanthin (sold by DSM as OPTISHARP Natural) in reducing blue light or light-induced damage in patients with three common ocular disorders (Global Lutein Market 2018-2022). Asia-Pacific is expected to be the fastest-growing lutein market over the projection period, owing to increased urbanization and rapid industrialization, as well as subsequent growth in the consumer markets of countries like China, India, and others. North America is expected to have a relatively high growth rate in the global lutein market due to the region's developing ophthalmology sector, particularly in the United States (Anonymous, 2021-26).

Conclusion

Over the past decade, Marigold has become a popular loose flower and there is a growing trend among growers to cultivate Marigolds for both aesthetic value and seed production. The highly developed and attractive foliage and inflorescence of this plant make it both a great potted plant and a suitable ornamental crop. Growing potted marigolds that are quick to produce is an advantage for growers to meet the increasing demand for the plant. Marigold flowers (*Tagetes*) are rich in lutein, a carotenoid pigment that ranges in hue from yellow to orange-red. Lutein is a carotenoid pigment that is yellow and belongs to the xanthophyll family. Lutein is beneficial to reduce different eye conditions like Dry Eye Syndrome (DES) by decreasing inflammation on the ocular surface and is also beneficial for other tissues to improvethe cognitive function of the brain. In poultry feed, the substance lutein from marigold is an excellent source of pigment that contributes to the yellow color of egg yolks and enhances the color of chicken skin. It has also been found that Lutein supplementation improves milk output, lactose content, and fat content in the milk and milk quality in nursing cows by increasing their antioxidant capacity and preventing illnesses. Also, ethanol-based luteinis being used to dye fabrics especially cotton, resulting in a variety of colors. In addition to that, *T. erecta* provides a lemon-yellow color shade that, when added to food goods, boosted the attractiveness of the food by giving it a lemon yellow tint. It has been estimated that the global lutein market to USD 734.60 million with a CAGR of 12.72 percent by the year 2027 from USD 356.70 million in 2021. Asia-Pacific is expected to be the fastest-growing lutein market over the projection period, owing to increased urbanization and rapid industrialization, as well as subsequent growth in the consumer markets of countries like China, India, and others.

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