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Ecofriendly Marigold Dye as Natural Colourant for Fabric

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Abstract

This chapter highlights on the applications of marigold plant extracts as an antibacterial and antimicrobial best dyer for textiles. *Tagetes erecta* usually known as Marigold is a vital wellspring of carotenoids and lutein, developed as a nursery plant. Marigold blossoms are yellow to orange red in colour. Now a days, lutein is transforming into an unquestionably common powerful fixing, used as a part of the medicines, food industry and textile coatings. This has increased more noticeable vitality of marigold and its exceptional concealing properties. Regardless of the way that marigold blooms; its extract has been used as a measure of veterinary supports. The examination was directed to contemplate the usage of a concentrate of marigold as a trademark shading, which is antibacterial and antimicrobial. The marigold extract ability was focused on colouring of the cotton fabrics. Investigations of the dye ability, wash fastness, light fastness, antibacterial tests and antimicrobial tests can be endeavoured. Studies have exhibited that surface concealing was not impacted by washing and drying in the shadow/sunlight. These surprises reveal that the concentrate of marigold extract can be used for cotton fabrics.

Keywords: dyeing, marigold, colour fastness, fabric, antibacterial, antimicrobial

1. Introduction

Marigold is a common name of *Tagetes* species, a genus of herbs and the member of the Asteraceae family. It is a native of Mexico and other warmer parts of America and naturalised elsewhere within tropics and sub tropics. In India it is cultivated as garden plant. The flowers which are yellow to orange in colour with corymbose clusters are much used for garlands and functions and also used to decorate households during celebration of festivals.

These plants do not require any additional care. They grow in all conditions of the environment. Marigold plants bare sun, heat, drought and grow in any well-drained soil. Marigolds are easy to grow even from transplants also. Marigold requires a mild climate for smooth growth and flowering. Mild climate is required during the growing period is 14.5° - 28.6°C and it improves the production of flowers at higher temperature (26.2° - 36.4°C). Depending on the climatic conditions, the marigold grows three times in a year – rainy, winter, and summer seasons. The different coloured flowers are shown in **Figure 1**.



Figure 1.
The types of marigold flowers available in India.

The earliest use of marigolds was by the Aztec people who attributed magical, religious and medicinal properties to marigolds. The first recorded use of marigolds is in the De La Crus-Badiano Aztec Herbal of 1552. The Herbal records the use of marigolds for treatment of hiccups.

The orange, yellow and reddish yellow (i.e. red) colour flowers contain several pigments which appear to vary with source and soil nature. The active ingredients found in marigolds are plant sterols called calendulin, calendic acid, polysaccharides, polyunsaturated fatty acid, carotenoids, flavonoids, triterpenes saponins, like triterpenoid, Tocopherols, oleanolic acid glycosides.

The aqueous extract of flowers showed activity against gram positive bacteria. An infusion of plant is employed against rheumatism, cold and bronchitis. Root extract is employed as laxatives. Marigold leaves are utilised in kidney troubles and muscular pains. The infusion of florets is prescribed as a diuretic and carminative. The florets are utilised in the treatment of eye diseases and ulcers. The oil obtained from the fresh flowers incorporates a paralysing effect on the spinal marrow. It is used as antiseptic also. The flower heads are said to possess stimulant and anti-helminthic properties. Their juice contains iodine and is employed on cuts and wounds.

India is producing a big amount of marigold flowers. It is mainly used for floral offerings to Goddess and also for decorative purpose. After its use, the flowers were thrown away as garbage in ponds and rivers, which creates a lot of pollution. Our main aim of this chapter is to bring an awareness about the employability of marigold in many applications.

2. Uses of Marigold

The flowers of marigolds are very beautiful with a lot of benefits make a garden as more attractive. Marigold and its extracts are highly useful in therapeutic

treatments like headaches, swelling, toothache, wounds and numerous skin problems. In addition, they have been used in cooking. Marigold was one of the earliest cultivated flower. The ancient Greeks used the petals of marigold for decorations and other purposes like make-up, colouring food (stews, soups, pudding, etc), dying fabrics and as part of medicines. The significant uses of marigold flowers are deliberated as follows:

2.1 As a garden plant

2.1.1 Nematode control

The roots and stems of marigolds emit a chemical that will suppress the population of root-knot nematodes, tiny soil borne worms that prey on the roots of decorative plants and vegetables. It appears that French marigolds, particularly the 'Tangerine' variety, are the best against the destructive pests.

2.1.2 Beneficial to insects

Marigolds itself attracts many insects that are harmful to other plants of the garden, so that the other plants get protected from the pests and do not require any pesticides.

2.1.3 Beautifies the garden

Marigolds are capable of growing in hot shades with many colours like orange, yellow, red, mahogany or with combinations. Flowers are of a single, double or multi-layered and sizes vary from 6 inches to 3 feet. So makes the garden more gorgeous and increases the beauty of the garden.

2.1.4 Marigold companion benefits on planting

When marigold is planted nearby cruciferous and tomato plants, these plants get protected from worms. It is because of the scent released from marigold, which confuses the pests. So it avoids usage of chemical pesticides. Marigold is additionally a decent companion when planted near bush beans, squash, cucumbers and brinjal.

2.2 As a medicinal plant

The very important uses of marigold with respect to antioxidant properties as medicine are as follows.

2.2.1 Homemade skin treatment

Ointments made up of marigold are used to heal sunburns, acne and ulcerations in addition to healing of wounds, dry skin and blisters.

2.2.2 Digestive-soothing tea

Tea powder made with marigold flowers lowers the symptoms caused by inflammatory bowel diseases. Marigold tea is useful in solving gastric and ulcer problems as well as in reducing stomach cramps. The florets are consumed in tea form to assist ease digestion internally and improve liver health.

2.2.3 Immunity booster

Marigold extracts are accustomed to manage symptoms of coughs, sore throats or fever. So it can also be used as immunity booster.

2.3 Treatment for fungal infections

2.3.1 Lowers inflammation and oxidative damage

Research shows that active chemicals of marigold make it a natural cytotoxic, hepato-protective, and spasmogenic herb, that has been used in both animal and human trials. Extracts obtained from the flower contains C-reactive protein and cytokine levels which protect cells from being damaged like ageing and cell deterioration.

Marigold controls oxidative damage from free radicals which will affect delicate tissues of the skin, GI tract and genitals caused by viruses or bacteria [1]. In addition, research also shows that marigold helps to reduce the growth of bacteria's in wounds and might even be ready to reduce symptoms related to chemotherapy and cancer treatments [2].

2.3.2 Reduces eye inflammation and conjunctivitis

Marigold extracts are used for treating conjunctivitis and other chronic ocular inflammatory conditions of animals. As these extracts have shown antibacterial, antiviral, antifungal and immuno-stimulating properties and which can be used on delicate tissues of the eyes against oxidative damage [3].

2.3.3 As a natural antiseptic

The extract of Marigold is employed to treat bacterial ear infections and reduce pain. It has been identified that marigold drops can lower inner-ear swelling and inflammation very easily in a short period and even without the use of antibiotics. Marigold extract may be used as antifungal for treating fungal infections of ear [4].

2.3.4 Heals skin wounds, burns and rashes

From the traditional days the marigold is employed for treating irritated skin to cut back itchiness, redness, sensitivity, dryness and swelling. It found that marigold has the power to push the expansion of healthy new tissues, increasing the rate of blood flow to the affected areas and boost collagen production, which firms and strengthen the skin, hydrate dry skin and speed up the method of skin repair following surgery or damage.

Marigold's ability to support the treatment of wounds is believed to be the secretion due to stimulation of somatic cell production, which contains glycoproteins and nucleoproteins. It is also associated with increased cell turnover and improved collagen metabolism stimulation.

In folklore medicine, marigold products were applied to varied ulceration (both internal and external) and on wounds to stop infections, and even today marigold is employed during post-surgery to push faster incision healing.

Marigold extract is combined with natural lubricating products and applied on dry and rash-prone skin that will help to enhance skin hydration and firmness. The extract of marigold is employed topically to reduce rashes on the sensitive skin, discoloration, unsightly varicose veins, dermatitis, eczema, bruises and scalp dandruff. It used to treat swollen bug bites, burns, and infected cuts and decreases other signs of poor blood flow and inflammation affecting the skin.

2.3.5 Eases cramps and spasms

Marigold's analgesic property is useful for relieving muscle spasms, stomach cramps and PMS/menstrual cramps. It reduces cramping by improving blood circulation to the painful area and lowering inflammatory responses [5].

2.3.6 Mosquito repellent

Due to their pungent odour, antioxidant content and volatile oils, marigolds are often accustomed naturally repel mosquitoes, pests and other insects. This is often one reason as marigold commonly planted in vegetable gardens. The flowers of Marigold are employed as extract form in candles, room/ bug sprays, and lots of skin lotions so as to forestall mosquito bites. Use of marigold products on our skin helps to repel bites. The flowers' aroma works underground to stay away nematodes (microscopic worms) [6].

2.4 Marigold as perfume

Many *Tagetes* sp. of marigold yield strong aromatic oil and referred as *Tagetes* oil. The *tagetes* oil is principally used for the compounding of high grade perfumes. The oil from French marigold L. is produced chiefly in France and finds a decent market within the perfumery trade.

In India French marigold L. appears to be a promising source of the oil on account of its fairly high yield with true floral character and favourable tagetone content. The flowers are regularly distilled in India for the assembly of attars by absorbing their steam distillate over sandalwood oil or liquid paraffin. It also acts as fly repellent and is credited with larvicidal properties.

2.5 Natural dye

India has a rich, diversified plant kingdom, which is a treasure house of varied natural products. Natural dye is one such product. The natural colourants mainly flavonoids and carotenoids present in the Marigold were extracted by different techniques and used as natural colourants on different fabrics. The use of natural colourants exists from ancient period.

3. Dye of marigold

Dyes are one of the foremost important yields of plants. In most of the countries, natural dyeing is practiced only on handicrafts and artificial dyes are being employed altogether for commercial dyeing processes. The problems related to synthetic dyes arise during their application, manufacture, and process of synthesis, intermediates formed and other raw materials involved.

Now a days with the global concern on the use of eco-friendly and biodegradable materials, around the world the solicitation of natural dyes in the textile industry is enhanced. The interest in the utilisation of eco-friendly and biodegradable materials create the employment of natural dyes. In contrast, natural dyes are environmental friendly, exhibit better biodegradability and customarily have the ensuing compatibility with the environment than synthetic dyes [7]. Natural Dyeing may be carried out by using eco-friendly bath methods like alkaline bath, acidic bath, or neutral bath. The method is economically viable because the raw materials are available at low cost, which in turn reduces the

cost of production. There are several articles available on different methods of mordanting on different fabrics, for dyeing with different natural dyes.

Dyeing of cotton and silk with marigold brings a growing interest within the revival of natural dyes in textile colouration [8]. The main idea of extracting dyes from marigold plant sources is to avoid environmental pollution and its characteristics like antibacterial, antifungal, etc. The application of various mordants along with marigold gives innumerable shades like brown, yellow, orange and so on to the fabric.

Dyes derived from marigold sources have emerged as a significant alternative to synthetic dyes. The dyes produced were dyed on cotton fabric and tested for colour fastness to washing properties. Mordants were used to fix the colour on the fabrics. The dyes obtained from the marigold plant are replaceable to synthetic dyes.

Light fastness of the numerous natural dyes, particularly which are extracted from flower parts is found to be poor to medium [9]. In earlier days India was a significant exporter of herbal dyes to the world. Now days the demand for natural dyes has augmented, because of the ban on the assembly of a variety of synthetic dyes and intermediates within the developed countries, thanks to the pollution problem [10].

3.1 Process of dyeing

The procedure involved in dyeing of cotton with marigold extract comprises the following steps

- Pre-Treatment
- Extraction of colourant
- Mordanting (fixing dye with fibre)
- Dyeing

3.1.1 Pre-treatment

Before carrying out the dying process. Fabric undergoes scouring. Scouring is a process used to remove the dust and other colourants present on fabric. During scouring, the cotton fabrics were washed in a solution containing x g/L soda ash and a couple of g/L non-ionic detergent solution at 50° C for 25 min, keeping the fabric to required liquor ratio. The scoured material was thoroughly washed with H₂O and dried at moderate temperature. The scoured material must be soaked in clean water for 40 min before dyeing or mordanting.

3.1.2 Extraction of colourant

Flowers from the plant source were dried in trays, in thin layers, in an exceedingly current of warm air immediately after picking. Then crushed and dissolved in water and allowed to boil over a water bath for two hours for the quick extraction. All the colour was extracted from flowers was filtered for immediate use.

3.1.3 Mordanting

It is a method where mordant is used to fix the dye on fabric. Mordant binds dye with fabrics by forming a complex, which then confers to the fabric. Most of the natural dyes have no substantively on textile fabrics without the utilisation

of a mordant. All most all the natural dyes need a mordanting chemical to make an affinity between the fabric and dye [11].

During mordanting, the weighed cotton samples were treated with a different metal salt. The different percentage of mordant was dissolved in water to create a required liquor ratio. The wetted sample is immersed into the mordant solution and so dropped at heating. The temperature of the dye bath was raised to 80°C over a period of half an hour and left at that temperature for 30 minutes. The mordanted material should be rinsed with water and dried in shadow. Mordanted cotton must be used immediately for dyeing because some mordants are very sensitive to light.

Generally mordants are metallic salts form a metal complexes with the fibres and dyes [12]. After completion of mordanting, the metal salts fixed to the fabrics, attract the dye pigment molecules. For example if aluminium sulphate mordant is used, it induced into the fabric and helps to fix the natural dyes through either coordination bonds or hydrogen bonds and by other inter molecular forces [13].

3.1.4 Dyeing

The cotton samples must be dyed with dye extract, keeping required M:L ratio. The marigold dye extract has prepared by adding \times gm dye powder in y ml of water. Dyeing was carried out by standard dyeing method. After dyeing, the dyed material was washed with cold water and dried at low temperature. Then it has been dipped in brine for dye fixing.

4. Purpose of natural dye

Mainly the colours generated from natural resources like marigold are vibrant, biodegradable, and non-allergic. These features indicate that they are far compatible with the environment and to be used around humans. It is easy to extract the natural colour from plants, fruits or flowers. Many natural dyes even have antimicrobial properties, making them safer for teenagers specifically.

Natural dyes will not contain harmful chemicals nor carcinogenic components, common to artificial or synthetic dyes [14]. Usage of natural dyes will help to preserve the environment and lowering human dependence on harmful products. When toxic runoff and residuals from the textile manufacturing and dyeing process often find yourself in our delicate oceans, we must always do and make sure that we are using the nontoxic alternative, natural dyes.

Furthermore, the products employed in producing natural dyes, particularly plants, produce no waste, unlike the products employed in the synthetic dyeing process. Because plants bypass the complete production process which takes to form synthetic dyes. This can be one more reason why natural dyes are infinitely better for the environment. By using natural dyes instead of synthetic dyes, we are ready to be closely connected to nature and recognise the importance it plays altogether of our lives. The main advantage of naturally dyed fabric is that they are capable of absorbing higher UV rays. By wearing clothes dyed naturally, you are able to protect your skin more from the UV rays. The natural dyes can be used on fabrics for different purposes.

4.1 Intention of Marigold dye

4.1.1 To provide different colour effect on fabric

Marigold flower is grown altogether parts of India throughout the year and maybe an honest source of material for natural dyes. Three different shades of

Marigold flowers are available in India; those are light yellow, golden yellow and orange mix yellow. These were taken as raw materials for natural dyeing of cotton fabrics. Depending upon the thickness of the colour, the amount of flower is soaked in a specific amount of water to extract the required colour. The 30 g of extract powder is mixed with 100 ml of water for about 30 minutes for extraction. However, in the case of orange-yellow and light yellow, the extraction time was 50 minutes.

Cotton material is used to dye with the extracts obtained from three different shades of marigold after mordanting with eight different mordants in each case. All the specified cases of attractive shades may be produced by such dyeing. The colour fastness property to washing of most of the dyed samples was within the range of 2–3 percent in general. Colour fastness to light of the dyed samples varied with the change of mordant and therefore the substrate.

4.1.2 To enhance antibacterial/antimicrobial properties of fabric

Cotton fabric is employed in many applications in the textile industry due to its unique properties. However, the antibacterial properties of marigold extract will help within its applications in hygienic textiles and employed in medical fields. Flowers of marigolds are generally used to worship in temples and decorate vehicles [15]. The dyed SPF fabrics were then evaluated for colour values, fastness properties, anti-bacterial activities in addition to the durability of the identical. The studies give us clarity regarding the benefits of using such mordants in case of achieving antibacterial/antimicrobial functionality with addition of eco-friendliness [16]. Marigold dyeing by using most typically found alum mordant was also distributed for comparison of the aim.

5. Materials and experimental processes

5.1 Materials

Plant material: Marigold (*Tagetes erecta*).

The scientific classifications are as follows.

Kingdom – Plantae

Order – Asterales

Family – Asteraceae

Genus – *Tagetes*

Species – *T erecta*

5.1.1 Plant description

A stout, branching herb as shown in **Figure 2** is 60 cm tall, native of Mexico, extensively cultivated as a border - annual in gardens all over India. Roots usually taproot system, Stems usually erect; Leaves strong scented, pinnately dissected: segments 1–5 cm long, oblong or lanceolate, serrate; flower - heads solitary, yellow to orange, 5–9 cm across, florets bisexual, pistillate, functionally staminate, rays many, long-clawed, sometimes two-lipped or quilled, involucre campanulate; fruit achenes, 6–7 mm long, usually dry with relatively thick, tough pericarps, sometimes beaked (rostrate) and/or winged (late), often dispersed with aid from pappi; Seeds 1 per fruit, exalbuminous; embryos straight. The flower samples of four cultivars of *T. erecta* (marigold) i.e., marigold orange (MGO), marigold yellow (MGY), marigold reddish yellow or red (MGR) were collected (**Figure 3**).



Figure 2.
Marigold plant.



Figure 3.
Different colours of marigold.

5.2 Experimental process

5.2.1 Extraction of marigold powder

The petals were separated, sun-dried, powdered, and stored at -20°C for further studies (**Figure 4**).

5.2.2 Extraction of lutein ester

The fine powder of the petals of marigold orange, marigold yellow, marigold reddish yellow of about 30 gm was used to extract with various solvents. The extraction was carried out under dark conditions by covering the apparatus with black cloth together with the condenser. The extract was filtered and concentrated to dryness in an exceedingly rotary evaporator under reduced pressure and at 40°C , this stored in a container at -20°C (**Figure 5**).

5.2.3 Identification and extraction of fatty acids

The concentrated extract of different cultivars of marigold flower petals containing lutein esters was saponified in presence of 40% methanolic potassium hydroxide at 60°C for 1 h under dark condition. The unsaponifiable matter containing free lutein was extracted by three times using hexane. The water layer was acidified to



Marigold Flower



Marigold Dried Petals



Marigold Powder

Figure 4.
Extraction process of marigold.

liberate the free fatty acids and extracted three times with petroleum ether. The ether fractions were collected and the solvent was removed under vacuum. The fatty acids were converted to methyl ester according to the standard method [13] and fatty acid composition was analysed by using a gas liquid chromatography.

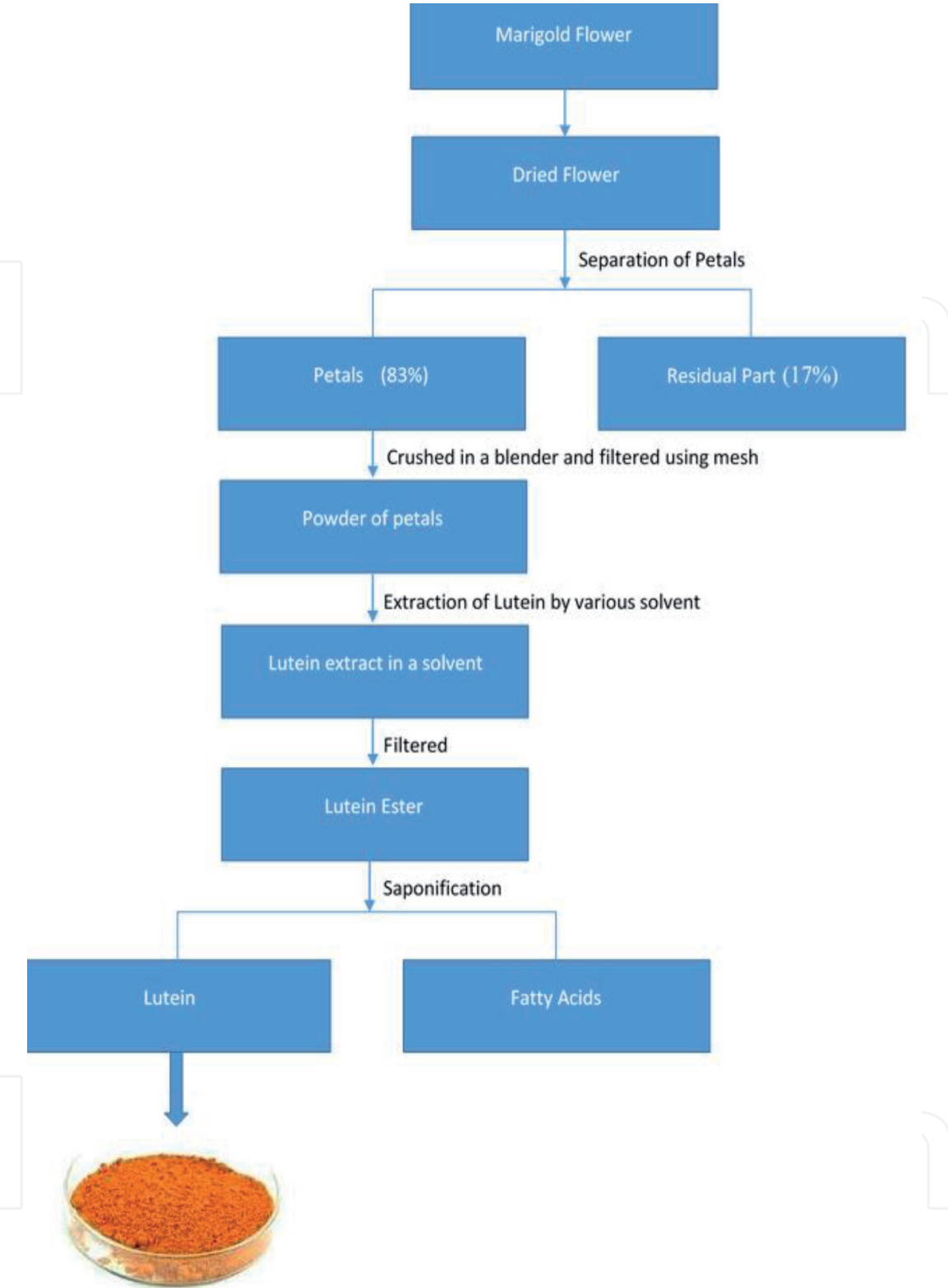


Figure 5.
Preparation and extraction of lutein.

6. Conclusion

The fabric dyeing process using marigold (*Tagetes erecta*) helps us to come to a general conclusion. Indian Marigold grows in all type of soil with different atmospheric condition and the required care to grow the marigold plant is very minimal. Marigold with rich quality of making garden beautiful have wide range of additional benefits. It has been used in the medicines, foods and in textile industry from

ancient days. The marigold extracts are effective in protecting unsaturated fatty acids in the emulsion system. Marigold extract is used as a colouring agent.

Now days it is used in the fabrication of fabrics for colour dyeing and to provide antibacterial, antifungal and antimicrobial effects on fabric. Marigold dye arises as natural dye and free from harmful chemicals. Natural dye extraction is very simple and user friendly. Flower extract contains rich lutein esters. These extracts are used as antioxidant component in various food and pharmaceutical formulations.

Overall investigation has generated a lot of information on Indian marigold and its extract, which are highly beneficial in textile industry. This information can create commercially importance to produce viable products from Indian marigold for food, pharmaceutical industries and Textile industry.

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