International Journal of Research in Pharmacology & Pharmacotherapeutics (IJRPP)

ISSN: 2278-2648

IJRPP |Vol.15 | Issue 1 | Jan - Mar -2026

www.ijrpp.com

DOI : https://doi.org/10.61096/ijrpp.v15.iss1.2026.319-330

Review

FUTURE PROSPECTS OF NATURAL DYES IN TEXTILES AND COSMETIC INDUSTRY

Dr. L. V. Vigneshwaran*, Mohammed Riyaskhan, Thilagavathi. M, Siva Ranjani. A, Mohan Kumar. S, Balamurugan. G

RKP College of Pharmacy, Krishnagiri, Tamil Nadu – 635001

*Corresponding Author: Dr. L.V. Vigneshwaran
E. mail Id: vigneshwaran85@gmail.com

Published on: 04.03.2026

Published by: Futuristic Publications

Abstract

Natural colorants made from plants, animals, and minerals were the main source for dyeing and printing for thousands of years. Due to their consistency and cost, synthetic dyes gradually took over the market, but their use has resulted in serious health hazards, including mutagenic and carcinogenic consequences, as well as environmental damage. This has led to a resurgence of interest in natural, environmentally friendly substitutes, especially in the textile and cosmetic sectors.

The peels of pomegranates (*Punica granatum L.) contain important tannins and the coloring agent granatonine, making them a powerful natural dye source. According to research, ethanol water solutions can be used to successfully extract crude dye from pomegranate peels, which can then be refined for use on silk and leather. Sustainable colouration with increased fastness can be attained by optimising dyeing parameters like temperature, duration, and pH and by using natural mordants and fixing agents like gum rosin.

Keywords: Natural colorants, pomegranates (*Punica granatum L.), granatonine

INTRODUCTION NATURAL COLORANTS

The application of colour through printing and dyeing Every civilisation has relied heavily on techniques. In the past, natural materials were used to make dye plants, animals and minerals that haven't undergone any chemical processing. For thousands of years, people have used vegetable dyes by humanity (1). Additionally, synthetic dyes were more affordable and easily synthesised, provide superior and more consistent hues with improve fastness characteristics to different agencies. But a lot of artificial dyes, especially azo dyes made from It has been discovered that ex-aryl amines may cause cancer. (causing cancer).Some substances utilised in the production of Additionally, dyestuffs are thought to be mutagenic and carcinogenic as well as allergenic or sensitising (2,3)

The Greek phrase "kosm tikos," which translates to "having the power, organise, or ability in beautifying," is where the term "cosmetics" originates. In the cosmetics industry, colours are essential since they attract and capture consumers' attention. In the marketing of any product, including apparel, food, and cosmetics, colours are essential. These days, women's lives are greatly impacted by cosmetics. In their daily lives, women use a wide range of cosmetics, such as lipstick, nail paint, hair colour, perfume, skin care products, and more. However, some of these products include colorants. Young people have recently been more interested in getting tattoos on their bodies, using a range of colours and pigments.

The majority of hues used in cosmetics are artificial colours or dyes. Among the most widely used synthetic dyes in cosmetics are xanthone, quinoline, indigo, and azo dyes. The synthetic dyes were eventually found to have harmful and carcinogenic effects. Germany banned these specific azo dyes in 1996 after it was found that they were the most dangerous of these several synthetic colours. It has been found that synthetic dyes are not eco-friendly. There are several problems associated with synthetic colours. At that point, people started employing natural pigments in cosmetics.(4)

CLASSIFICATION OF NATURAL COLORANTS

There are several ways to categorise natural dyes. In the past, dyes were arranged alphabetically for classification. Later, a variety of other classification techniques were accepted, and they are:

- Chemical structure-based classification
- categorisation according to their source or place of origin
- Categorisation according to their application techniques
- Categorisation according to colour

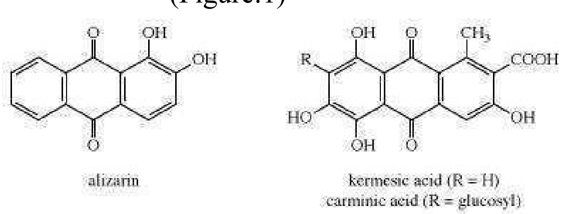
Natural dyes are categorised and categorised in the Colour Index based on both their primary use and chemical makeup .(5) Natural dyes are grouped by hue within application class in a distinct area of the Colour Index.(6)

HISTORY OF DYES

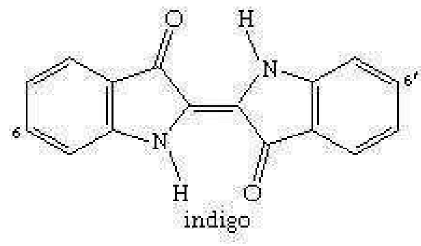
Until the 1850s, almost all dyes came from natural sources, mostly vegetables like plants, trees, and lichens, with a few coming from insects. Dyed textiles discovered in Egyptian tombs offer compelling proof that dyeing techniques date back more than 4,000 years. Natural dye extraction and application are described in ancient hieroglyphs. Only about a dozen natural dyes have been widely used despite countless attempts to extract dyes from vividly coloured plants and flowers. The majority of attempts undoubtedly failed because most natural dyes are not very stable and are found in complex mixtures that would be difficult to successfully separate using the rudimentary techniques used in the past.

Nevertheless research on these dyes in the 1800s served as a foundation for the creation of synthetic dyes, which by 1900 controlled the market. Alizarin and indigo are two natural dyes. have a significant impact. A crimson dye called alizarin is obtained from the madder plant's roots. Scale insects were used to make two additional red dyes. These include cochineal, which comes from Dactylopius coccus, which inhabits prickly pear cacti in Mexico, and kermes, which comes from Coccus ilicis (also known as Kermes ilicis), which infects the Kermes oak. An estimated 200,000 insects can yield one kilogramme (2.2 pounds) of cochineal dye. These colours' primary coloured ingredients are carminic and kermesic acids, respectively, whose resemblance was founded by 1920. The presence of sugar residues in their natural condition makes many colourants soluble in water. However, during dye isolation processes, these sugars are frequently lost.

(Figure:1)



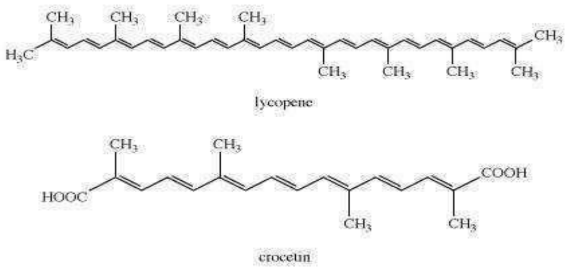
The blue dye indigo, which is made from the indigo plant in Asia and the leaves of the dyers woad herb in Europe, is perhaps the oldest known dye. Even by current standards, both alizarin and indigo have very good dyeing characteristics, and indigo remains a favoured dye for denim, although synthetic indigo has supplanted the natural substance.



(figuer;2)

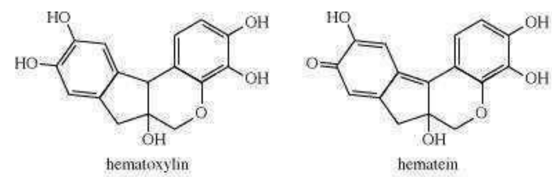
With a process developed by the Phoenicians, a derivative of indigo, Tyrian purple, was extracted in very small amounts from the glands of a snail, indigenous to the Mediterranean Sea. Experiments in 1909 yielded 1.4 grams (0.05 ounce) from 12,000 snails. Historically, this dye was also called royal purple because kings, emperors, and high priests had the exclusive right to wear garments dyed with it, as is well documented in the Hebrew Bible and illustrated for Roman emperors on mosaics in Ravenna, Italy. By the 1450s, with the declineof the Eastern Roman Empire, the Mediterranean purple industry died out.

Natural yellow dyes include louting, from the leaves of weld, and quercetin, from the bark of the North American oak tree. These are in the flavonoid family, agroup of compounds occurring almost exclusively in higher plants and producing the colors of many flowers.In fact, these compounds can produce all the colors of the rainbow except green. Luteolin, a yellow crystalline pigment, was used with indigo to produce Lincoln green, the colour associated with Robin Hood and his merry men. Another group of compounds, the carotenoids, present in all green plants, produce yellow to red shades. Lycopene ,from which all carotenoids are derived, produces the red colour of tomatoes.An ancient natural yellow dye, crocetin, was obtained from the stigmas of Crocus sativus; this dye is undoubtedly derived from lycopene in the plant. Few of the flavonoid and carotenoid colorants would have survived ancient extraction processes.



(Figure:3)

Logwood is the only natural dye used today. Heartwood extracts of the logwood tree, Haematoxyloncampechianum, yield hematoxylin, which oxidizes to hematein during isolation. The latter is red but in combination with chromium gives shades of charcoal, gray, and black; it is used mainly to dye silk and leather.



(figure;4)

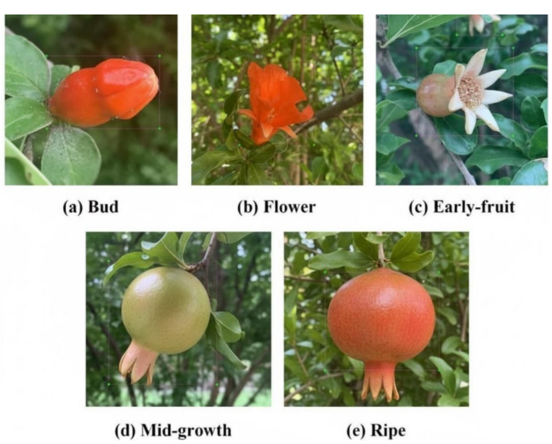
Table .1 Wave length and absorption in organic dyes

Wave length absorbed(nm)	Colour absorbed	Colour observed
400-435	violet	Yellow-Green
435-480	Blue	Yellow
480-490	Green-blue	Orange
490-500	Blue-green	Red
500-560	Green	Purple
560-580	Yellow-Green	Violet
580-595	Yellow	Blue
595-605	Orange	Green-Blue
605-700	Red	Blue-Green

POMEGRANATE (PUNICA GRANATUM.L)

Punicagranatum belongs to the Punicacea family. It originated in Persia and is now found in all warm nations. The outer layer of Pomegranates have a significant tannin content roughly 19% with pelletierin. Granatonine, which is found in the alkaloid form N-methylgranatonine, is the primary colouring ingredient in pomegranate peels. This substance provides the dye its colour. Studying it will help us comprehend the colouring compound's structural chemistry. More than 500 plant species that produce dyes have been given to mankind by nature . Thes plants'

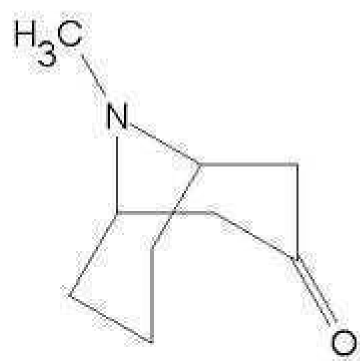
colouring compounds come from their roots. fruits, trunks, bark, or leaves. Plants are the source of all rainbow colours (Cage). Natural dyes are often more environmentally friendly and have superior biodegradability. They are readily available, renewable, non-carcinogenic, non- toxic, and non-allergic to skin. One of the oldest known edible fruits in the world is the pomegranate (Punicagranatum L.). Since ancient times, it has also been utilised in traditional medicine(7).It is thought that the pomegranate originated in Central Asia, which is currently occupied by Afghanistan and Iran(8); (9); Simmonds 1976) (10). It was initially grown in Egypt, Greece, Italy, and Iraq before spreading to other Asian nations, especially those in North America and Mediterranean Europe(11). Many tropical and subtropical regions currently cultivate more than a thousand pomegranate cultivars .nations (12). Pomegranate flowers are utilised extensively in traditional medicine, including Ayurveda systems, in addition to its fruits. Evidence from science has demonstrated the beneficial bioactivity of pomegranate flower extracts in both human and animal systems (14).



(figure;5)

The textile, paper, cosmetic, food, pharmaceutical, and leather sectors are among those that typically utilise dyes (15,16). One of the main causes of water pollution is the release of nonbiodegradable coloured wastewater from the production of textile dyes and textile-dying operations. environmental issues in the modern world. Synthetic dyes that add strong colour to receiving aquatic habitats cause both aesthetic and major ecological issues, including carcinogenicity and suppression of benthic photosynthesis. (17, 18). Dyes are mostly released into the environment through the textile industry's effluent, which utilises and rejects large volumes of water. The vivid colour and high quantities of organic and inorganic compounds seen in textile effluents are created by leftover dyes that were not adhered to the fibres during the dyeing process.(19)

Structure of Granatonin



Raw material preparation :

After gathering the pomegranate peels, they are properly cleaned with water to get rid of any contaminants. The samples were ground into a powder using a grinder after being dried at room temperature.The figures below depict them.

Extraction of crude dyestuff :

To make crude dyestuff, 500 millilitres of ethanol water(40:60) were added to 100 grammes of powder in a round-bottom flask. The flask was then heated in a water bath at 60 degrees Celsius for 60 minutes. The solution was then filtered to obtain crude dyestuff. We used varying concentrations of ethanol during the extraction process; the yield of crude dyestuff was 18.52% when laboratory grade 95% ethanol was used, it

was 13.21%.

Purification of crude dyestuff :

Using the Soxhlet apparatus at 70°C for three hours, the crude dyestuff is distilled to obtain one-third of the solution. This procedure yields concentrated dye and recovers ethanol. For precipitation, the solution is left at room temperature for the entire night. The precipitation in ethanol water is produced by decanting the solution. The resulting particles are dried overnight at 60°C in the oven. The Soxhlet device was filled with water. Water lowers the compounds' boiling points, enabling them to evaporate at lower temperatures. The purification procedure is the same regardless of the solvent concentration.

CULTIVATION

Location: Pomegranates will grow and flower in some shade, but for optimal fruit, they should be put in the warmest, sunniest area of the yard or orchard. The pomegranate is a great landscaping plant because of its lovely foliage, blooms, and fruits, as well as its little stature.

Soil: The pomegranate grows best in regular soil that drains well, but it can also flourish in calcareous or acidic loam and gravel that has been strewn with rocks.

Irrigation: Pomegranates can withstand severe drought once they are established, but they need irrigation to produce fruit. During the dry season, new plants should be watered every two to four weeks to let them establish. The plants can withstand soil and water that are somewhat salinised.

Fertilization: During the first two springs, trees in the West receive two to four ounces of ammonium sulphate or another nitrogen fertiliser. After that, the plants respond to an annual mulch of decomposing manure or other compost, but very little fertiliser is required.

Pruning: When a plant reaches a height of around two feet, it should be trimmed back. Allow four or five shoots to grow from this point; they should be spaced equally around the stem to maintain the plant's equilibrium. These should have a short but distinct trunk, beginning at a height of roughly one foot above the ground. Both suckers and any shoots that emerge above or below should be eliminated. It is advised to carefully trim the branches every year for the first three years in order to promote the greatest number of new shoots on all sides, avoid straggly development, and create a robust, well-framed plant because the fruits are only produced at the points of new growth. Only dead branches and suckers are removed after the third year

Propagation : Although the pomegranate can be grown from seed, it might not bear fruit. Cuttings are easy to root, and after three years or so, the plants that grow from them give fruit.Cuttings that are 12 to 20 inches long should be removed from mature, one-year-old timber in the winter. After removing the leaves, the cuttings should be treated with rooting hormone and inserted into the soil or another warm rooting media for roughly two thirds of their length.

Although grafting is rarely successful, plants can also be air-layered.

Pest and diseases: Pomegranates are relatively free of most pests and diseases. Minor problems include leaf and fruit spot, as well as foliar damage from scale insects, mealy bugs, thrips, and white flies. Deer will graze on the leaves, which are similar to apples in that they have a long shelf life, but gophers hardly ever disturb the roots. It can be stored for seven months at 32° to 41° F and 80% to 85% relative humidity without shrinking or going bad.

Harvest : The pomegranate is ripe when it has grown a characteristic color and produces a metallic sound when tapped. The fruits must be collected before they reach over maturity, when they have a tendency to crack open, especially when it rains on them comparable to an apple in terms of its extended shelf life. It can be stored for seven months at 32° to 41° F and 80% to 85% relative humidity without shrinking or going bad.

Commercial potential : The Near East, India and its neighbouring nations, and southern Europe are the world's main commercial growth regions. The southern San Joaquin Valley is the hub of commercial growing in California. There isn't much consumer demand in this nation. (20)

Material and techniques

Materials

In September 2020, pomegranate (Punica granatum L.) peels were gathered from nearby fresh fruit juice vendors in Kunming City, Yunnan, China. We bought gum rosin and Chinese quince (Chaenomeles speciosa) fruits from a local market in Heqing County, Dali Bai Autonomous Prefecture, China. Chaka Town, Wulan County, Qinghai Province, China, provided the mineral salts. We bought rare earth from Nanchang City in Jiangxi Province, China. Hydrochloric acid (HCl), sodium hydroxide (NaOH), and ethanol (EtOH) were all of analytical reagent quality. Throughout the investigation, distilled water was utilised. Esquel Enterprises Ltd. supplied fabrics made of bleached silk (weight 16.0 g m^{-2}, plain weave).

Techniques extraction of pomegranate peels

After being cleaned with water and allowed to dry at ambient temperature (20–25°C), the pomegranate peels were crushed into a powder. The pulverised peel was extracted in distilled water at a liquor ratio of 1:30 in a water bath at 100°C for 30 minutes in order to produce pomegranate peel extract with a mass fraction of 6%. For use as a natural dye, the mixture was chilled and filtered. Making a natural fixing agent Gum rosin was ground into a powder and

added to 800 mL of ethyl alcohol and 200 mL of distilled water at room temperature to make a 15 g/L natural fixing agent solution. The combination was

utilised as a natural fixing agent after being constantly agitated until the gum rosin powder had dissolved.

Fourier transform-visible and ultraviolet-infrared spectroscopy

Using Fourier transform infrared spectrometry (Nicolet iS10, Thermo Fisher Scientific), 16 scans at a resolution of 4 cm−1 in a spectrum range of 4000–400 cm−1 were used to get the FT-IR spectra of pomegranate peel extract. Spectral data was obtained using the KBr pellet technique.

Pomegranate peel extract was subjected to UV-visible spectroscopy

Using a UV-5500PC spectrophotometer (Shanghai metash Instruments Co., Ltd) that scanned between 190 and 600 nm. design of an experiment to investigate the characteristics of pomegranate peel dye The best conditions for using pomegranate peel extract to dye silk fabrics were found using an orthogonal design. Three variables were chosen (temperature [A], time [B], and pH [C]), and their dyeing levels (1, 2, and 3) were experimentally regulated.

Table 2.Factors and levels selected for the orthogonal array experiment for dyeing fabrics with pomegranate peel extract

Level	A. Temperature (0C)	B. Time	C.PH
1	40	30	5
2	60	60	7
3	80	90	9

Table .3 orthogonal array design used for the nine dyeing experiments based on design L8(33)

No	A(Temperature)	B(Time)	C(PH)
1	A1	B1	C1
2	A1	B2	C2
3	A1	B3	C3
4	A2	B1	C2
5	A2	B2	C3
6	A2	B3	C1
7	A3	B1	C3
8	A3	B2	C1

Table 2 lists the three levels of each factor employed in the orthogonal experiment. As indicated in Table 3, nine tests each were conducted using silk fabrics based on the Orthogonal experimental design L9(33)

Dyeing

Samples of silk fabric were dyed at a liquor ratio of 30:1 using pomegranate peel extract with a mass fraction of 6%. Temperature (40, 60, or 80°C), duration (30, 60, or 90 minutes), and dye pH (5, 7, or 9) were among the parameters examined (Sadeghi-Kiakhani et al. 2019) (21) After being cleaned with distilled water, the coloured textiles were allowed to dry at room temperature.

Moderating technique

Three natural mordants (20 g/L C. speciosa, 10 g/L mineral salts, and 5 g/L rare earth) were used in pre, simultaneous, and post-mordanting procedures at 80°C for 30 minutes at a liquor ratio of 30:1 (Yanget al.2021 (22); Zheng, Hong, and Liu 2011 (23).

Colour-fixing procedure

To fix the color, the dyed materials were submerged in gum rosin dye-fixing agent at a 30:1 liquor ratio at 70°C for 30 minutes while being continuously stirred. Following treatment, the dyed textiles were allowed to dry, rinsed with distilled water, and then allowed to dry again at room temperature. Dyeing and colour fixation were done using three different methods: first,

natural mordant, then dye, then dye-fixing agent; second, natural mordant + dye, then dyefixing agent; and third, dye, then natural mordant, then dyefixing agent.

Dimensions of colour

Using an Illuminant D65 and 10° standard observer, a tabletop spectrophotometer (Shenzhen Three NH Technology Co., Ltd.) was used to measure the colour properties of the dyed samples, such as lightness (L*), redness-greenness (a*), and blueness-yellowness (b*). The reference samples came from materials that had not been dyed. The Kubelka-Munk equation was used to determine K/S:

$$K/S = (1 - R)\ 2/2R,$$

Where S is the scattering coefficient, K is the absorption coefficient, and R is the reflectance of the colored fabric.

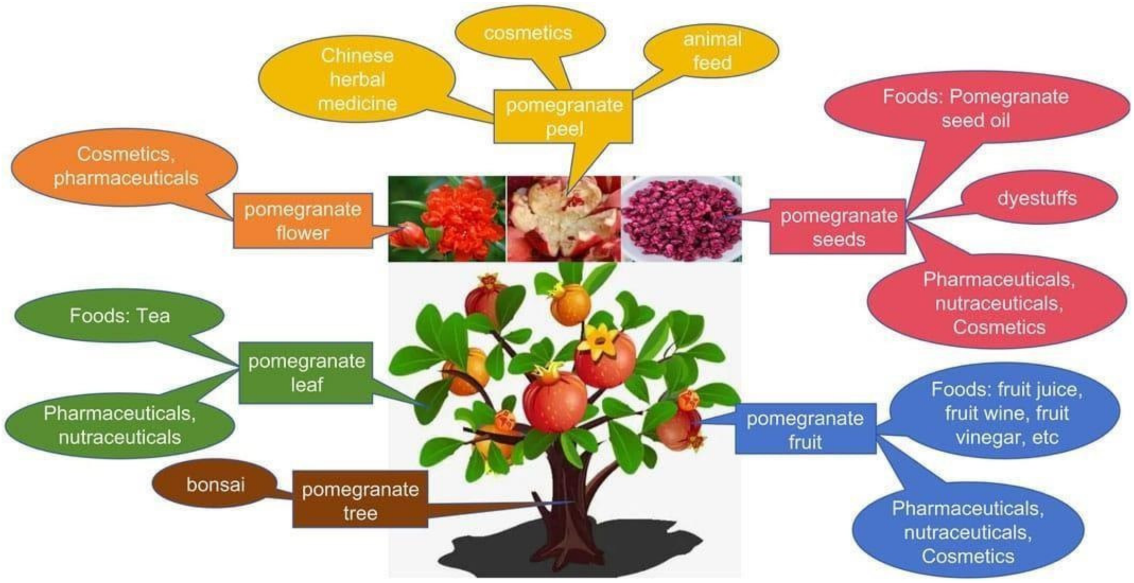
Tests for color fastness

The Chinese Textiles Test Specification, which is based on worldwide ISO standards, was used to test the colour fastness of the dyed samples. Standards GB/T3921–2008, GB/T3922–2013, and GB/T3920–2008 were used to measure the colour fastness to washing, perspiration, and rubbing (National Standard of the People's Republic of China 2008a(24a), 2008a(25b), 2013(26).

Analysis using scanning electron microscopy

Scanning electron microscopy (SEM; ZEISS EVO LS10) was used to examine the surface morphology of dyed fabric fibres both before and after the colour fixing process. We looked at and examined the surface morphological characteristics of coloured cloth fibres.

APPLICATION



RESULT AND DISCUSSION

Findings and Discussion The study showed that pomegranate peel's high tannin and granatonine content makes it an efficient natural coloring source. A reasonable dye yield was obtained using ethanol–water extraction, with higher ethanol concentrations achieving maximum recovery. Temperature, duration, and pH were found to have a substantial impact on color depth and consistency on silk materials when dyeing parameters were optimized. Dye absorption, surface morphology, and color fastness to washing, rubbing, and perspiration were all enhanced by the use of natural mordants and gum rosin as a fixing agent. Overall, the findings support pomegranate peel dye's viability as an environmentally responsible and sustainable substitute for synthetic dyes.

CONCLUSION

The transition from synthetic to natural dyes is becoming more and more important because of the serious health and environmental hazards that artificial colourants pose, including their mutagenic and carcinogenic qualities. Pomegranate (Punica granatum L.) is a highly efficient, renewable material for environmentally friendly dyeing, according to this study. The fruit's peels provide a sustainable substitute for the textile and cosmetic sectors since they are high in tannins and the colouring agent granatonine.

According to experimental results, an ethanol-water solution can effectively extract crude dyestuff with a yield of up to 18.52%. Silk textiles can be coloured deeply and steadily with optimised parameters, particularly controlling temperature, duration, and pH. Additionally, the use of fixing agents like gum rosin and natural mordants like C. speciosa and mineral salts greatly improves surface morphology and colour fastness. The industry may lessen the ecological impact of textile operations and decrease water contamination by using these biobased products. In the end, pomegranate peel extract turns out to be a practical, non-toxic, and biodegradable option for superior, environmentally friendly dyeing procedures.

REFERENCES:

1. Mohanty, B.C.; "National Seminar on Natural Dyes",Jaipur, NHDC, (1989).
2. Ramakrishna K., *Colourage,* Vol. XLVI (July 1999) 29.
3. Gulrajani M.L., *Colourage,* Vol. XLVI (July 1999) 19.
4. Mohana PM, Chidambara RP, Lavanya M. use of natural pigments as colorants in cosmetics – a review: Volume 7. JETIR March 2020
5. Colour Index, Vol. III 3rd ed., Society of Dyers and
6. **Sekar N., Colourage, Vol. XLVI, (July 1999) 33.**
7. Levin GM (1994) Pomegranate (Punicagranatum) plant geneticresources in Turkmenistan. Bulletindes Ressources Phytogenetiques(IPGRI/FAO), Noticiario de Recursos Fitogeneticos(IPGRI/FAO)
8. Harlan JR (1975) Crops and man. Am Soc Agron 1:284. https ://doi. org/10.2135/1992.crops andman.c9.
9. Levin GM (2006) Pomegranate roads: a Soviet botanist's exile from Eden. B.L. Baer (ed.). Floreat Press, Forestville. pp 15–183
10. Simmonds NW (1976) Evolution of crop plants. Longman, London
11. Levin GM (2006) Pomegranate roads: a Soviet botanist's exile from Eden. B.L. Baer (ed.). Floreat Press, Forestville. pp 15–183
12. Ghosh SN, Bera B, Roy S, Kundu A (2009) Effect of plant growth regulators in yield and fruit quality in pomegranate cv. Ruby. J Hortic Sci Biotechnol 4:158–160
13. Huang THW, Peng G, Kota BP, Li GQ, Yamahara J, Roufogalis BD, Li Y (2005) Anti-diabetic action of Punicagranatum flower extract: activation of PPAR-gamma and identification of an active component. ToxicolApplPharmacol 207:160–169. https ://doi.org/10.1016/j.taap.2004.12.009
14. Khalil EAM (2004) Antidiabetic effect of an aqueous extract of pomegranate (*Punicagranatum*L.)peels in normal and alloxan diabetic rats. Egypt J Hosp Med 16:929
15. M.S. Chiou and H.Y. Li, *J.* Hazard. Mater., **93**, 233 (2002).
16. I. Banat, P. Nigam, D. Singh and R. Marchant, *J. Bioresour. Technol.*, **58**, 217 (1996).
17. E. Forgacs, T. Cserhati and G. Oros, Environ. Internat., **30**, 953 (2004).
18. T. Robinson, G. McMullan, R. Marchant and P Nigam, *J. Bioresour. Technol.*, **77**, 247 (2001).
19. P. Cooper, Color in Dye House Effluent, Society of Dyers and Colorists, Bradford (1995).
20. http://en.wikipedia.org/wiki/Pomegranate#Prominence_in_Ayurvedic_medicine
21. Sadeghi-Kiakhani, M., A. R. Tehrani-Bagha, K. Gharanjig, and E. Hashemi. 2019. "Use of Pomegranate Peels and Walnut Green Husks as the Green Antimicrobial Agents to Reduce the Consumption of Inorganic Nanoparticles on Wool Yarns." Journal of Cleaner Production 231:14631473
22. .https://doi.org/10.1016/j.jclepro.2019.05.283.Yang, R., Y. Zhang, S. Ranjitkar, M. X. Li, Y. J. Guo, X. X. Yan, C. F. Wang, J. R. Stepp, and L. X. Yang. 2021."Reusing Wasteroot of Rubia Wallichiana Dyeing from Monpa of Tibet in China." Scientific Reports 11 (1): 14331. https://doi. org/10.1038/s41
23. Zheng, G. H., B. F. Hong, and G. P. Liu. 2011. "Application of Rare Earth for the Dyeing of Ramie Fabrics with Natural Dyes." The Korean Journal of Chemical Engineering 28 (11): 2148–2155. https://doi.org/10.1007/s11814-0110090-9.
24. National Standard of the People's Republic of China. 2008a. GB/T 39202008, Textile. Tests

for ColorfastnessColorfastness to Rubbing. Beijing, P. R. China: China Standard Press.

25. National Standard of the People's Republic of China. 2008b. GB/T 39212008, Textiles- Tests for ColorfastnessColorfastness to Washing with Soap or Soap and Soda. Beijing, P. R. China: China Standard Press.
26. National Standard of the People's Republic of China. 2013. GB/T 3922-2013, Textiles- Tests for ColorfastnessColorfastness to Perspiration. Beijing, P. R. China: China Standard Press.