NATURAL COLORS FROM EXTRACTIONS OF NATURAL PRODUCTS

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ABSTRACT:

Natural colors are very effective with low cost and fewer side effects. Now, these days' colors indicate flavors, for example, if the vanilla flavor is colored yellow, it will look like a pineapple. People can also be distinguished by color, for example, white, black, and brown. Similarly, man chooses different colors while buying any items. An object might be changed into a rainbow color like it from a natural extract. It is truly amazing. Another way of this is called green chemistry which does not cause any disturbance to the environment, natural products are used for therapeutic uses as well as coloring agents so mainly food industry replaced nature colors instead of organic synthetic colors.

Key words: *Natural extractions, Rainbow colors, green chemistry.*

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INTRODUCTION:

Natural colors are very effective with low cost and fewer side effects. Now, these days' colors indicate flavors, for example, if the vanilla flavor is colored yellow, it will look like a pineapple. People can also be distinguished by color, for example, white, black, and brown. Similarly, man chooses different colors while buying any items. An object might be changed into a rainbow color like it from a natural extract. It is truly amazing. Another way of this is called green chemistry which does not cause any disturbance to the environment, natural products are used for therapeutic uses as well as coloring agents so mainly food industry replaced nature colors instead of organic synthetic colors. Colour plays a vital role in human life. It influences emotions, buying behaviour, and perceptions of taste and quality. In the food industry, for example, a yellow tint may suggest a lemon or pineapple flavour, even if the flavour is actually vanilla. This psychological association emphasizes the importance of using safe and appealing colouring agents. With growing awareness about the harmful effects of synthetic dyes, industries are now turning to natural alternatives extracted from plants, fruits, flowers, and other organic sources. These natural pigments offer not only colour but also added health benefits and reduced environmental risks.

Sources of Natural Colours

Sources of Natural Colours and Their Eco-Friendly Extraction Methods

Natural colours have been used by human civilizations for centuries to enhance the aesthetic appeal of foods, textiles, cosmetics, and artworks. In today's world, where people are increasingly conscious of their health and environmental impact, there is a growing preference for natural colours over synthetic dyes. These colours are derived from a wide variety of renewable and biodegradable sources such as plants, fruits, flowers, roots, seeds, algae, and even certain microorganisms. Not only do these natural sources provide vibrant shades, but they also bring added health and environmental benefits. Let's explore these sources in detail and understand how they are processed in an eco-friendly way to retain their natural goodness.

1. Plants and Fruits as Colour Sources

Plants and fruits are among the richest sources of natural pigments. Each plant part—whether the root, stem, leaf, flower, or fruit—can contain specific compounds that yield different colours. These colours are generally the result of naturally occurring pigments such as anthocyanins, carotenoids, betalains, and chlorophyll.

- **Beetroot**, for example, is widely used as a natural red or magenta pigment. The deep reddish-purple colour comes from betalains, which are water-soluble pigments. These are commonly used in juices, sweets, and food decorations.
- **Turmeric** offers a bright yellow colour due to the presence of curcumin, a compound known not only for its vibrant hue but also for its strong antioxidant and anti-inflammatory properties. Turmeric has been used in cooking, traditional medicine, and textile dyeing for generations.
- **Spinach** is another excellent example. It provides a rich green colour, derived from chlorophyll. The pigment is highly sensitive to heat and light, so modern extraction methods must ensure its preservation during processing.
- **Blueberries** are valued for their deep blue and purple hues, thanks to anthocyanins. These pigments are also potent antioxidants, making them desirable not just for colouring but for their health-promoting properties.
- **Annatto seeds** produce a bright orange pigment known as bixin and norbixin. These pigments are lipid-soluble and are often used in cheese, butter, and margarine to give them a creamy golden look.

In all these cases, the fruits and vegetables are carefully processed to extract their pigments in the purest form, ensuring they are safe for use in food and cosmetic products.

2. Colourful Flowers

Many flowers naturally contain brilliant and attractive colours that can be extracted and used in various applications. They not only provide aesthetic value but also contain bioactive compounds beneficial for health.

- **Hibiscus flowers** yield a red pigment rich in anthocyanins. These are used in herbal teas, syrups, and cosmetics. In many cultures, hibiscus extracts are also consumed for their potential to lower blood pressure and support heart health.

- **Marigold** is another popular source, especially for its vibrant yellow and orange tones. The colour comes from a group of carotenoids, primarily lutein and zeaxanthin, which are also beneficial for eye health. In the poultry industry, marigold extract is sometimes added to feed to enhance the yolk colour of eggs.
- **Butterfly pea flowers** produce a deep blue pigment due to the presence of anthocyanins. Interestingly, this pigment is pH-sensitive and can change colour in acidic or basic conditions—turning purple in lemon juice and green in alkaline solutions. This makes it a fun and interactive ingredient for natural food colouring and drinks.

The pigments in flowers are delicate and often require gentle extraction methods to maintain their stability and colour quality, which is where eco-friendly techniques come into play.

3. Roots and Seeds

Roots and seeds are another reservoir of natural pigments with deep traditional roots in food, medicine, and textiles.

- **Saffron**, obtained from the stigma of the *Crocus sativus* flower, is one of the most expensive and revered natural colourants. It imparts a golden yellow hue and has a distinctive aroma. Its colour comes from a compound called crocin. In addition to culinary uses, saffron is known for its antidepressant and anti-inflammatory properties.
- **Turmeric**, though also a rhizome, deserves mention here again due to its widespread use in seed and root forms.
- **Mustard seeds**, especially the black and brown varieties, release a yellow to brown pigment upon grinding. They are mainly used in culinary applications and sometimes as natural preservatives due to their antimicrobial activity.

The pigments from roots and seeds often require drying, grinding, and extraction under low temperatures to preserve their volatile oils and colour quality.

4. Algae and Microorganisms

In recent years, algae and certain microorganisms have emerged as highly efficient and sustainable sources of natural pigments. They can be cultivated in controlled environments, making them scalable and consistent in quality.

- **Spirulina**, a type of blue-green algae, produces a greenish-blue pigment called phycocyanin. This pigment is used in smoothies, dietary supplements, and natural candies. It is rich in protein, vitamins, and antioxidants, making it a powerful health booster.
- **Red yeast rice**, a product of fermenting rice with the yeast *Monascus purpureus*, produces a pinkish-red pigment. In Asian cuisine, it is traditionally used to colour and flavour food such as Peking duck and rice wine. Additionally, it contains monacolin K, which has cholesterol-lowering properties.

These microbial pigments are considered future-forward solutions, especially because they can be produced without harvesting land crops, thus saving water and reducing agricultural pollution.

Eco-Friendly Extraction Methods

To retain the purity, vibrancy, and safety of these natural pigments, several **eco-friendly extraction methods** are employed. These methods minimize the use of harsh chemicals and reduce environmental impact:

1. **Cold Pressing**: This method involves mechanically pressing the plant or seed material at low temperatures to release the natural pigments. It is ideal for extracting colour from oily seeds or fruits like annatto or turmeric. The low temperature helps in preserving sensitive compounds.
2. **Aqueous Extraction**: Water-based extraction is widely used for water-soluble pigments like betalains from beetroot or anthocyanins from hibiscus. It is a clean, safe, and sustainable method suitable for food-grade applications.
3. **Solvent-Free Techniques**: These methods use mechanical separation, enzymatic treatments, or supercritical CO_2 extraction to avoid harmful chemical solvents. Supercritical CO_2 extraction is

particularly promising, as it can extract both volatile and non-volatile compounds while leaving no toxic residues.

4. **Ultrasound and Microwave-Assisted Extraction**: These are modern methods that improve pigment yield and reduce energy usage. They break down cell walls more effectively, releasing the pigments quickly while maintaining their bioactivity.

These green extraction technologies are crucial for maintaining the "natural" label of the pigments while ensuring scalability and safety for human consumption.

Advantages of Natural Colours

Natural colours offer multiple benefits compared to their synthetic counterparts:

- **Non-toxic and Safe:** Natural pigments are generally recognized as safe (GRAS) and are suitable for use in food and pharmaceuticals.
- **Eco-friendly:** The extraction and usage processes follow green chemistry principles, minimizing harm to the environment.
- **Biodegradable:** These colours break down naturally and do not accumulate as pollutants.
- **Added Health Benefits:** Many natural colorants contain antioxidants, anti-inflammatory compounds, or vitamins that can offer health advantages.
- **Consumer Preference:** With the rise in clean-label products, consumers now prefer ingredients they recognize and trust.

Applications of Natural Colours

Natural colours are no longer just a trend — they have become a practical and health-conscious choice across many industries. Derived from plants, fruits, flowers, algae, roots, and even microbes, these colours are safe, environmentally friendly, and often carry beneficial properties like antioxidants and antimicrobial activity. Let's explore how natural colours are being used in various fields in ways that combine beauty, safety, and sustainability.

1. Food and Beverage Industry

Perhaps the most widespread use of natural colours is in the food and beverage sector. Consumers are becoming more cautious about what they eat and prefer "clean-label" products — those made with natural and recognizable ingredients. Artificial dyes, once common in candies and soft drinks, are being replaced with vibrant colours extracted from fruits, vegetables, and spices.

For example:

- **Beetroot extract** gives a natural red colour to juices, yoghurts, and energy drinks.
- **Turmeric** provides a rich yellow tint in pickles, sauces, and curry powders.
- **Annatto seeds** are used to give cheese, butter, and snacks an appealing orange hue.
- **Spirulina** adds a bright blue-green touch to smoothies and candies.

Natural colours enhance the visual appeal of food while also being safe to ingest. In many cases, they bring added health benefits, such as antioxidants and anti-inflammatory compounds, making them a win-win for producers and consumers.

2. Cosmetics and Personal Care Products

Beauty and skincare products are also experiencing a shift toward natural ingredients, including colourants. Natural colours are used in a wide variety of cosmetics like lipsticks, blushes, foundations, eyeshadows, and nail polishes.

- **Hibiscus and beet extracts** are used in lip and cheek tints for their rosy red shades.
- **Activated charcoal and indigo** offer natural alternatives for black or deep blue tones in eyeliners and mascaras.

- **Marigold and turmeric** are added not just for colour, but also for their soothing and antiseptic properties in creams, face masks, and soaps.

In personal care products like **shampoos, conditioners, body lotions, and soaps**, natural pigments help add aesthetic value while minimizing the risk of skin irritation or allergic reactions often caused by synthetic dyes. Brands promoting organic and herbal beauty lines prominently use botanical dyes to support their claims of being chemical-free and environmentally safe.

3. Pharmaceutical Industry

Natural colourants play a key role in the **pharmaceutical industry**, not just for aesthetic purposes but also for practical reasons like product identification, branding, and dosage distinction.

- **Coated tablets** are often coloured to help patients recognize them easily and avoid confusion between different medications.
- **Syrups and tonics**, especially those intended for children, use natural colours to make them more appealing and palatable.
- **Herbal supplements and Ayurvedic formulations** rely heavily on natural plant pigments, as they align better with the philosophy of natural healing.

Additionally, many natural colours such as curcumin (from turmeric) and anthocyanins (from berries) have therapeutic value and are being researched for their anti-inflammatory, anti-cancer, and antioxidant properties. This adds functional value to their colouring role, supporting the idea that natural colourants can be "nutraceutical" — offering both nutritional and pharmaceutical benefits.

4. Textile and Fashion Industry

The textile industry is rediscovering the benefits of **natural dyes** that were historically used long before the invention of synthetic colours. With rising awareness about environmental pollution caused by chemical dyes, many manufacturers and designers are turning to eco-friendly alternatives sourced from plants, roots, and flowers.

- **Indigo** is one of the oldest natural dyes, traditionally used to colour denim and other fabrics.
- **Madder root**, turmeric, and henna are used to create reds, yellows, and browns, especially in traditional garments and handmade crafts.
- **Marigold, neem, and pomegranate rinds** are being explored for new fabric dyeing solutions.

Natural dyes are biodegradable, non-toxic, and safe for workers handling the dyeing process. While they may not always offer the same colour fastness as synthetic dyes, they bring a rustic charm and sustainability story that appeals to ethical consumers. Designers in eco-fashion and handloom industries are championing these colourants for their authenticity and low environmental impact.

5. Art and Craft Supplies

Children's safety and environmental awareness are key drivers behind the use of **natural colours in art supplies**. As a result, paints, crayons, markers, and modelling clays are increasingly made with natural ingredients to ensure they are non-toxic, biodegradable, and safe if accidentally ingested or spilled.

- **Botanical pigments** like beetroot, turmeric, and spinach are used to create child-safe watercolours and finger paints.
- **Charcoal from coconut shells** or **clays** is used to make black and grey tones.
- **Natural binders** like gum arabic or honey are used instead of synthetic chemicals to hold colours together.

These eco-paints and biodegradable art materials are especially popular in preschools, homeschooling environments, and educational kits promoting sustainable living. Artists and hobbyists are also embracing them as part of a broader effort to reduce plastic waste and harmful chemicals in everyday creativity.

Green Chemistry and Sustainability

The extraction and application of natural colorants are closely aligned with the principles of green chemistry, which aims to:

- Reduce the use of hazardous chemicals.
- Promote renewable raw materials.
- Avoid waste generation.
- Design energy-efficient processes.

Using natural dyes reduces reliance on petroleum-based synthetic dyes and decreases chemical runoff into water bodies, making the process sustainable and safer for the ecosystem.

Challenges and Limitations

Despite their benefits, natural colours come with some limitations:

- **Stability:** They may degrade over time when exposed to heat, light, or oxygen.
- **Colour Intensity:** The vibrancy may not match synthetic dyes unless concentrated extracts are used.
- **Cost and Yield:** Extraction can be labour-intensive and more expensive due to seasonal availability and lower yield.
- **Regulatory Approval:** Some regions require extensive testing and certifications before allowing natural colour use.

However, ongoing research and technological advancements are helping to overcome these challenges through improved extraction techniques and encapsulation methods for colour stability.

FUTURE PROSPECTS

The future of natural colorants looks promising. With ongoing research in biotechnology, new microbial and plant-based sources are being explored for higher yields and better stability. Innovations such as nanoencapsulation, enzymatic extraction, and fermentation-based colour production are expected to enhance the effectiveness and cost-efficiency of natural pigments.

CONCLUSION

Nature offers a brilliant spectrum of colours through its diverse resources—plants, flowers, roots, seeds, algae, and even microorganisms. These sources are not only renewable and biodegradable but also provide health-promoting properties along with aesthetic appeal. As society moves toward cleaner and greener solutions, the demand for natural pigments continues to grow. With the support of eco-friendly extraction methods, natural colours can be effectively harnessed without harming the environment. These methods uphold the values of sustainability and safety, making natural colours a preferred choice in various industries, from food to cosmetics to pharmaceuticals. Natural colourants represent a harmonious blend of beauty, health, and sustainability. As awareness of environmental concerns and consumer health increases, industries are making a conscious shift toward natural dyes. These colours not only enhance product appeal but also align with the global movement toward green chemistry and sustainable living. While challenges such as stability and cost persist, advancements in science and technology are paving the way for wider adoption of natural pigments in various sectors.

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