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Economic Opportunities and Challenges in Commercialising Natural Dyed Handloom Products-A Systematic Review

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Abstract:
Developing environmental consciousness has led to a global increase in the use of natural dyes. They are mostly used in India's handloom industry to dye silk and cotton, which is then exported to the United States and Europe. Small enterprises and commercial dyers have recently shown a great deal of interest. "Economic opportunities and challenges in commercializing natural dyed handloom products" are the subject of this article's systematic review. The articles, which were found in EBSCO, Research Gate, and Google Scholar, covered the years 2000–2024. PRISMA 2020 (Preferred Reporting Items for Systematic and Meta Analyses) is the methodology employed for the review. To gather information, the researchers employed interviews, questionnaires, and observation. The Indian textile industry is increasingly using natural dyes from plant, animal, and mineral sources as sustainable alternatives to synthetic dyes, helping both the environment and traditional practices. This shift presents opportunities for India's export market while promoting cultural heritage and innovation in dyeing techniques. The article critically examines the dyeing industry's status, highlighting challenges such as technological advancements, environmental concerns, and market dynamics. It emphasizes the importance of sustainable practices and innovation to meet contemporary demands and discusses the socio-economic implications for dyers and the broader textile industry, balancing traditional methods with modern requirements.

Keywords: natural dye, challenges, handloom, socio economics, opportunities.

1. INTRODUCTION:

The handloom industry in India is a significant part of the country's cultural and economic fabric. It is one of the largest cottage industries, employing around 3.52 million people in direct and allied activities. Handloom products, such as sarees, kurtas, shawls, and bedspreads, are known for their unique craftsmanship and cultural heritage. The industry is eco-friendly, using natural fibers and minimal electricity. Despite facing challenges like competition from power looms and market instability, the handloom sector continues to thrive, especially in regions like Kerala, Assam, and West Bengal. The government has started various schemes to support and promote this traditional industry. The Indian handloom is one of the country’s largest unorganized economic activities and the warp and weft of Indian culture, particularly in the rural sector. Its craftsmanship and elegance portray our rich tradition and heritage’s history. The hand-spinning and weaving techniques of Indian weavers are famous over the world. The pandemic and lockdowns of the past two years have significantly altered the Indian economy and devastated the lives and livelihoods of citizens, particularly those who worked in MSMEs, where the

case of handloom is not an exception. The third handloom census report highlighted the key statistics that alarmingly demanded the need for a rebirth of the sector. It also exposed the terrible state of the Indian handloom.

2. Natural Dyes:

The Indian textile industry is increasingly using natural dyes from plant, animal, and mineral sources as sustainable alternatives to synthetic dyes, helping both the environment and traditional practices. This shift presents opportunities for India's export market while promoting cultural heritage and innovation in dyeing techniques. Natural dyes are colorants derived from natural sources such as plants, animals, and minerals. They have been used for centuries to color textiles, food, and other materials. Unlike synthetic dyes, natural dyes are biodegradable and generally less harmful to the environment. Common sources of natural dyes include roots, berries, bark, leaves, and insects. For example, indigo is derived from the leaves of the Indigofera plant, and cochineal dye comes from insects. Leaves, stems, barks, seeds, flowers, roots, and other plant parts are used to make the dyes. Natural resources abound in Assamese rural communities in northeastern India. Northeastern India is home to many trees that are excellent natural dye suppliers. The need for natural dye is high on the global market. People are rediscovering color today using natural, non-toxic, renewable resources all throughout the world.

3. Natural Dyes In The Handloom Industry:

The handloom industry using natural dyes offers many opportunities and challenges. Natural dyes contribute to environmental sustainability as they are biodegradable and non-toxic, providing health benefits by being non-allergenic and non-carcinogenic. There is a growing market demand for sustainable and organic products, and promoting natural dyes helps preserve traditional dyeing techniques, boosting rural employment and contributing to economic growth through exports. However, the industry faces challenges such as inconsistent raw material availability and higher costs compared to synthetic dyes. Natural dyes often have lower color fastness, and there is a lack of standardization in dyeing processes. Additionally, the handloom industry may lack advanced technology for efficient dyeing, making it challenging to compete with synthetic dyes. Overcoming these challenges is essential to enhance the industry's potential for sustainable development.

4. Objective:

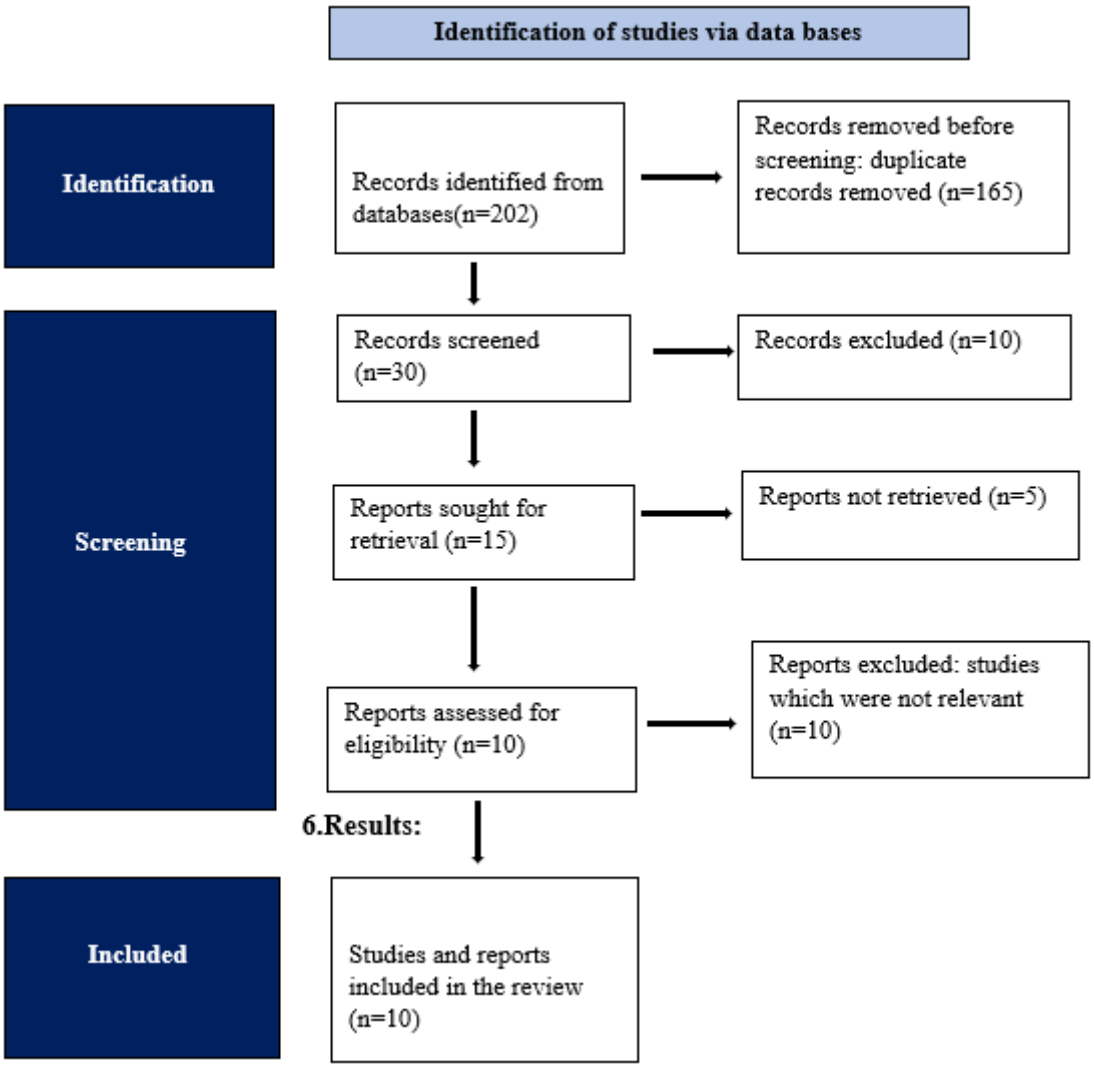
- Highlight the significance of the handloom industry in India.
- Analyze the economic opportunities in commercializing natural dyed handloom products.
- Evaluate the impact of natural dyes on the environment and consumer health.

5. Methodology:

Preferred Reporting Items for Systematic Review and Meta Analyses, or PRISMA 2020, was employed in the study. PRISMA 2020 is an emerging approach for assessing quantitative, qualitative, and mixed methodologies studies at the same time. The strategy was used to figure out the economic opportunities and challenges in commercializing natural dyed handloom products. The processes used are discussed in detail further down. The keywords chosen to search on google scholar, EBSCO and research gate were “natural dye”, “challenges”, “handloom”, “socio economic”, “opportunities”. A review of studies on the economic opportunities and challenges in commercializing natural dyed handloom products was

conducted. A thorough search was undertaken to discover relevant studies for this inquiry. This review included two key steps: (a) gathering all relevant papers based on a first search, and (b) selecting articles using inclusion and exclusion criteria. There were 10 google scholar, EBSCO and research gate results for this search. After the articles were checked, 165 studies were duplicated. A total of 30 works were assessed, with 20 of them (dissertations, chapters, review papers, and proceedings) being discarded due to their lack of relevance. After then, the eligibility of 10 full-text articles was established. Out of 202 articles given, 165 were rejected for assorted reasons, including studies which were not relevant to the topic. The remaining ten publications were then assessed to see which ones were linked to the economic opportunities and challenges in commercializing natural dyed handloom products. The following diagram depicts the full selecting process.

Figure 1: Identification of studies via databases



6. Results:

There were only 10 articles identified which were related to “natural dye”, “challenges”, “handloom”, “socio economic”, “opportunities”. The economic opportunities and challenges in commercializing

natural dyed handloom products were highlighted in this review. The findings are as shown in the following table 1.

Table 1: Economic opportunities and challenges in commercializing natural dyed handloom products

Source	Design	Sample	Method	Results
[Chakravarty, S., & Kakaty, R. H. ,2015]	The research design is comprehensive and combines qualitative review, oral traditions, and experimental methods.	The study focuses on natural dyes from plants, insects, and minerals found in Assam, such as marigold, turmeric, indigo, and lac.	Primary, secondary data collection and analysis and Experimental analysis (for dyeing techniques).	The study shows that natural dyeing in Assam is hindered by limited knowledge transfer and lack of proper documentation, despite abundant natural resources. The commercial success of natural dyes is affected by competition from synthetic dyes and the absence of standardized methods.
[Harini, N., & Santhi, N. ,2023]	Experiments are being conducted to extract natural plant dyes and apply them to textile materials.	The study examines natural dyes from plants like turmeric, neem, beetroot, cabbage, and marigold, and considers animal-derived dyes.	Literature review, Experimental method and testing, Analyzing results for conclusion.	The study found that natural dyes, such as neem and turmeric, are environmentally safer compared to synthetic dyes, showing reduced BOD, COD, and TDS levels. However, natural dyes have varying color fastness, with superior performance at lower temperatures but poorer results at higher temperatures, showing the potential for sustainable textile products.
[V.K., R., & Vijayakumar, B. S. ,2023]	The research design is descriptive and analytical.	The study examines data and insights from various stakeholders in the handloom industry, including	The study uses qualitative research methodologies.	The study shows that the Indian handloom industry is in decline, with a significant drop in exports and a continuous decrease in the number of weavers. Despite government aid, the sector stays in a dire

		weavers, industry experts, and relevant literature.		state, emphasizing the urgent need for revival efforts.
[Ganesh S., 2008]	The design of the study is qualitative.	The study examines various vegetable dyes derived from plants like indigo, madder, safflower, annatto, turmeric, and pomegranate.	Descriptive research method	The study emphasizes the need for preserving traditional vegetable dyeing and calls for more research and development in raw material sourcing, extraction, and application. The growth of the natural dye sector is constrained by limited raw materials and requires improved marketing and scientific efforts to meet modern demands.
[De la Cruz Mercado, S. ,2021]	Quantitative and qualitative methodologies, experimental study		Quantitative and qualitative methodologies and questionnaire	Despite their limited color power, the study indicates that educating and involving consumers can boost adoption of natural dyes made from food waste. It points out the need for better dying techniques and the difficulties in obtaining raw materials, but it also emphasizes the financial benefits of co-design and personalization.
[Ramakrishnan, G., Poongodi, B., & Priyadarshini, R. ,2023]	The research design involves a comprehensive review of existing literature and practices,	The study examines data and insights from various handloom clusters, including Negamam and Pollachi.	The study employs a qualitative review method to assess the status of dyers in the handloom industry Interview.	The study emphasizes the need for sustainable and socially conscious methods by highlighting the difficulties faced by handloom dyers, such as hazardous working conditions, inadequate pay, and health hazards. It also demonstrates that if natural dyes prove to be as viable

				and efficient as synthetic ones, dyers will be open to using them.
[Belemkar, S., & Ramachandran, M. ,2015]	Qualitative and quantitative design	The study examines natural dye products and resources within the Indian textile industry.	Quantitative, qualitative and scientific studies	The research emphasizes the need for more scientific efforts to promote natural dyes, highlighting their comparable properties to synthetic dyes and their benefits for health and environmental sustainability. It underscores the importance of sustainable practices in the textile industry.
[Tripathi, G., Yadav, M. K., Upadhyay, P., & Mishra, S. K. ,2015]	The research design is experimental	Natural dyes extracted from pomegranate peels and marigold flowers; cotton/synthetic fabrics used for dyeing experiments.	The study employs quantitative research methodologies, including experimental procedures for dye extraction, mordanting, and dyeing processes.	The focus is on using natural color pigments in food, pharmaceuticals, and textiles to safeguard health and the environment. For natural dyes to be commercialized, they must meet the stringent standards of synthetic dyes, requiring extensive research and development.
[Xu, H., & Song, H.-y. ,2024]	The study adopts both quantitative and qualitative approaches.	Qualitative data collection using KJ method including interviews and expert consultations. Quantitative data collection using KANO model.	Statistical analyses, including reliability (Cronbach's alpha) and validity tests (KMO), were performed, and satisfaction coefficients were calculated to classify and prioritize	The results highlight that one-dimensional quality features (such as comfort, eco-friendly dyeing techniques, and durability) are critical for consumer satisfaction, while also identifying areas (like scalability and quality consistency) that need to be addressed for successful commercialization.

			demand attributes.	
[Vespignani, L.; Bonanni, M.; Marradi, M.; Pizzo, B.; Bianchini, R.; Goli, G,2023]	The study is designed as an experimental and quantitative investigation with a descriptive and analytical approach.	It involves laboratory experiments where natural dyes, DO30Nat and DV17Nat were applied to wood samples.	It includes several dyeing techniques, with analysis conducted via UV-Vis spectroscopy, colorimetric measurements, water washout test, and accelerated UV aging test.	The final results showed that while the dyes achieved vivid and uniform coloration with good water fastness, they exhibited significant fading under UV exposure, indicating a limitation for outdoor use proving that innovative natural dye technologies can provide a promising economic opportunity.

From the above table it is found that the studies conducted by various authors have conveyed that while natural dyed handloom products offer economic opportunities through sustainability and market differentiation, they face significant challenges such as high production costs, limited standardization, and competition from synthetic dyes, requiring extensive research, development, and consumer education to become commercially viable. The study also provides insights on focusing on one-dimensional quality features and provides promising technology that could increase the economic prospects by providing vibrant and eco-friendly hues that can enhance market appeal.

7. Reasearch Gap:

The studies show a significant gap in the documentation, standardization, and commercialization of natural dyes. Despite the abundant natural resources available, there is limited knowledge transfer and inadequate documentation of traditional dyeing methods. This lack of standardized practices, combined with competition from more readily available synthetic dyes, severely hinders the widespread adoption and commercial success of natural dyes. The absence of cohesive documentation makes it difficult to set up consistent quality and efficacy in dyeing processes, which is essential for scaling up production and meeting market demands. Additionally, the traditional knowledge of natural dyeing is often held by a few artisans and is not widely given, leading to a loss of valuable cultural heritage and skills.

8. Discussion:

This section summarizes the key findings and contrasts them with previous studies. The livelihood of artisans can be enhanced by creating eco-friendly, value-added handloom items with natural dyes, according to multiple writers [1]. The demand for eco-friendly and sustainable products is rising globally, which could benefit the handloom industry. There is a lot of potential for exporting handloom goods, particularly those made with natural dyes [11]. However, power looms and inexpensive synthetic substitutes pose a serious threat to the handloom industry [1]. Financial incentives and policy support for craftspeople are inadequate [10]. Craftspeople find it challenging to compete due to the high cost of production and supplies needed [11]. The handloom industry's prosperity is hampered by a lack of

marketing assistance and market accessibility [1].

9. Conclusion:

Comprehensive research and development is desperately needed to close this gap. In order to improve the quality and consistency of natural dyes, this involves identifying high-yielding dye plant species that can be grown sustainably as well as refining extraction and application techniques. To guarantee that these products satisfy industrial standards and can rival synthetic dyes, it is essential to establish standardized procedures for the extraction, application, and quality control of natural colors. Furthermore, in order to increase demand and spread knowledge about the advantages of natural dyes, it is imperative to engage customers through marketing and education. A market that values and seeks out natural dyed items can be created by educating consumers about the benefits natural dyes have for the environment and human health when compared to synthetic alternatives. The industry can guarantee that natural dyeing remains a practical and eco-friendly choice by encouraging sustainable processes. A diversified strategy is needed to close the research gap and advance the commercialization of natural dyes. Important elements include thorough research and development, consumer education, encouragement of sustainable behaviors, and the maintenance of traditional methods. By doing these things, we may increase the textile industry's acceptance and sustainability of natural dyes, promoting environmental sustainability and providing craftsmen with financial prospects.

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