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Sustainable Value Addition of Sericulture By-products: Economic and Cultural Significance of Silk Cocoon Handicrafts

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study explores the value addition potential of cut and pierced silkworm cocoons, a by-product of mulberry silkworm grainage operations, through the fabrication of innovative handicrafts. Eight types of bio-crafts cocoon flowers, flower vases, wall hangings, dream catchers, bird swings, single flower garlands, flower "bunch" garlands, and traditional cocoon pose (thoranam) were

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developed using dyed cocoons and locally available decorative materials. Fabrication methods involved shaping dyed cocoons into petals, leaves, and ornamental components, and assembling them with glue or stitching. Economic analysis revealed that the flower “bunch” garland provided the highest net profit (Rs. 245 per unit), followed by cocoon bird swing (Rs. 155) and cocoon flower vase (Rs. 150). Products such as wall hangings and single flower garlands offered quick turnover with low material costs. The results highlight the dual benefits of cocoon bio-crafts in promoting eco-friendly waste utilization and generating supplementary income, particularly for rural women and underemployed households. Adoption of cocoon handicrafts as a commercial activity could enhance value addition in the sericulture sector while preserving cultural heritage and supporting sustainable rural livelihoods.

Keywords: Cocoon handicrafts; silk cocoon crafting; sericulture by-products; value addition; rural entrepreneurship; economic feasibility.

1. INTRODUCTION

Sericulture, the art of silk production, encompasses the cultivation of mulberry, silkworm rearing, and post-cocoon activities leading to the production of silk yarn. Beyond its primary role in silk production, cocoons are also utilized for creating various value-added products. Among these, silkworm pieced or cut cocoons an immediate by-product obtained from silkworm seed production centres (grainages) after egg production hold significant potential for alternative uses. With the rising costs of sericulture, adding value to such by-products offers an effective strategy to supplement income and ensure the sector’s sustainability. The handicrafts sector plays a vital role in the nation’s economy, providing employment to a vast segment of rural and semi-urban artisans, generating substantial foreign exchange, and preserving cultural heritage (Boonchoo, 2006). Handicrafts possess immense potential, not only for sustaining millions of existing artisans but also for creating opportunities for new entrants into craft-based activities. One promising avenue is the conversion of cocoon by-products into bio crafts (Kaul & Pandey, 2014). Unlike natural flowers, which wilt quickly and serve only a temporary decorative purpose, cocoon-crafted products such as flower vases, bouquets, garlands, wall hangings, and gift items are durable, visually appealing, and capable of retaining their shine for years. Such items not only serve as long-lasting mementos but also enhance interior décor and carry sentimental value (Pagán *et al*., 2020). Recent studies have reinforced the socio-economic and environmental value of cocoon by-product utilization. Cocoon crafting has emerged as an avenue for economic empowerment, particularly for rural women, providing income generation, skill development, and creative engagement (Fenomanantsoa, 2006). Research has shown that converting cut or defective cocoons into crafted goods can increase post-cocoon product value by up to 30% (Karnataka Study, 2024), while biochemical analyses of sericin a silk protein have revealed antiproliferative bioactivity against human tumor cell lines, suggesting potential biomedical applications. Sustainability-focused reviews emphasize the role of cocoon-based crafts in promoting circular economy practices within the silk industry, thereby enhancing ecological responsibility. Comprehensive assessments indicate that systematic utilization of sericulture by-products can boost industry value by up to 40% (Pharma Journal Review, 2022). Additionally, innovations in tasar silk processing have expanded the application of by-products such as pupae, sericin, and chitosan into cosmetic and pharmaceutical sectors (CSB-CTRTI, 2024). The importance of silkworm cocoon bio crafts lies in their multiple advantages: they are eco-friendly, have a long shelf life, create job opportunities, integrate well with interior decorations, and can be developed into viable cottage industries. They also provide entrepreneurial avenues for women, particularly underemployed housewives, enabling them to engage in full-time income-generating activities while contributing to cultural preservation and rural development

2. MATERIALS AND METHODS

2.1 Basic Raw Materials

The primary raw material for cocoon handicraft fabrication consisted of cut or pierced cocoons obtained from silkworm egg production centres (grainages), as described by Sharma *et al*. (2022). In addition, rejected cocoons malformed, double, or containing dead pupae were utilized as a cost-effective substitute to enhance resource efficiency and economic returns.

2.2 Auxiliary Materials

Depending on the type of handicraft, various supplementary materials were employed, following the approach outlined by Mandre and Kumar (2006):

- **Cutting and shaping tools**: Scissors, zig-zag cutters, and blades for shaping cocoons and cutting decorative paper.
- **Binding and structural supports**: Cotton thread, jute thread, needles, fancy plastic/wire stems (or soft wire substitutes), and satin ribbons.
- **Decorative and adhesive materials**: Fabric glue, gum, craft paper, glaze paper, velvet paper, adhesive tape, colour tape, beads, plastic ornamental components, and staplers.
- **Colouring agents and tools**: Chemical dyes, fabric paints, watercolours, sketch pens, and paintbrushes.
- **Other materials**: Plastic bottles (used as vase bases) and velvet sheets (used in flat flower bouquet preparation).

2.3 Tools and Their Applications

Adapted from Mandre and Kumar (2006):

- **Scissors:** Cutting designer paper sheets and shaping cocoons.
- **Zig-zag cutter:** Producing serrated edges in garlands or bird feathers.
- **Fancy plastic/wire stems:** Forming the stem structure of cocoon flowers.
- **Satin ribbon:** Decorative tying of bouquets.
- **Velvet sheet:** Providing base for flat bouquets.
- **Gum and fabric glue:** Bonding cocoon components during assembly.
- **Beads:** Enhancing aesthetic appeal in caps, garlands, and decorative pieces.
- **Stapler:** Securing edges of bouquets and greeting cards.
- **Plastic bottles:** Serving as structural bases for cocoon flower vases.
- **Jute thread:** Used in cocoon wall hanging fabrication.

2.4 Cocoon Dyeing Procedure

Dyeing was performed to enhance the visual appeal of the cocoons prior to crafting, as recommended by Kaul & Pandey (2014). Although natural dyes are preferable for adding value and authenticity, chemical dyes typically used in silk yarn/fabric processing were also employed. Soft water was used exclusively to ensure uniform dyeing and minimize dye consumption.

Procedure:

1. Heat soft water to boiling and prepare a dye solution by mixing 100 g of dye powder with 100 mL of hot water.
2. Stir the mixture continuously to prevent clumping, then filter the solution.
3. Add the filtered dye solution to the hot water bath and stir until colour is uniformly distributed.
4. Introduce clean, deflossed, and rejected cocoons into the dye bath maintained at 50 °C to prevent sericin degradation and deformation (Kaul & Pandey, 2014).
5. Stir continuously until uniform colour absorption is achieved.
6. Remove the dyed cocoons and dry them in a single layer under shade to avoid decolouration.

The dyed cocoons were then stored in a clean, dry environment until further use in the fabrication of handicraft items.

2.5 Fabrication of Cocoon Bio-Crafts

Eight types of bio-crafts were fabricated: cocoon flowers, cocoon flower vase, cocoon wall hang, cocoon dream catcher, cocoon bird swing, single flower garland, flower “bunch” garland, and cocoon pose/thoranam. Each product was prepared by cutting dyed cocoons into desired shapes, assembling components with glue or stitching, and integrating decorative materials for visual appeal (Mandre & Kumar, 2006).

2.5.1 Cocoon flower

Natural flowers such as rose, chrysanthemum, tulip, sunflower, aster, crossandra, champak, jasmine, kakada, dasavala, tuberose, daffodil, lily, and lotus were visually studied to understand petal arrangement. Dyed cocoons were cut into 3–4 petals per cocoon. Three to four such cut cocoons were arranged in a floral pattern and fixed with fabric glue. After air drying, a soft fancy wire was inserted through the centre using a needle to form the stalk, knotted at both ends. Leaves were prepared from green-dyed cocoons or substituted with artificial plastic leaves.

2.5.2 Cocoon flower vase

Between 30 and 50 cocoon petals of different colours were arranged in rose-like configurations. Each flower was fitted with a fancy wire stalk or mounted onto a plastic water bottle stalk. The prepared flowers were assembled into a bouquet and arranged in a vase.

2.5.3 Cocoon wall hang

Dyed cocoons were cut into petal or bird shapes. Jute ropes or woollen threads were arranged in a circular pattern on cardboard or wrapped around bangles using glue. Petals or bird motifs were fixed to the base to form decorative wall hangings.

2.5.4 Cocoon dream catcher

Cut/pierced cocoons were given a shallow cut at one end with a zigzag scissor. A coloured cocoon was inserted into the cut cocoon, followed by one or two cocoon caps through the basal end. This sequence was repeated alternately with a needle and thread to form three garlands of varying lengths. These were fixed to a woollen thread–wrapped circular cardboard frame.

2.5.5 Cocoon bird swing

Cocoons were cut into small pieces shaped like bird body parts and assembled to form bird figures. These were fixed onto a chart-covered plastic pipe. Bird seats were suspended from round-shaped metal wire, which was wrapped with cocoon petals. The completed swings were mounted on a round-shaped cardboard base.

3. RESULTS AND DISCUSSION

3.1 Fabrication Outcomes of Cocoon Bio-Crafts

The present study successfully demonstrated the fabrication of eight categories of cocoon bio-crafts utilizing dyed cut or pierced mulberry cocoons. These included cocoon flowers, cocoon flower vases, wall hangings, dream catchers, bird swings, single flower garlands, flower bunch garlands, and cocoon pose/thoranam. Each product exhibited high resemblance to its natural or traditional counterpart, indicating that the structural properties of cocoons particularly their resilience, luster, and unique texture make them highly adaptable for handicraft production. The cocoon flowers were especially notable for their uniformity in petal shape and vibrancy of colour, characteristics that aligned well with consumer preferences for aesthetically appealing floral substitutes.

The use of supplementary materials such as beads, satin ribbons, and velvet sheets enhanced the decorative value, broadening the market appeal. Similar findings were reported by Bukhari (2024), who noted that the combination of natural fibers with modern decorative elements creates products that are more attractive to younger consumer segments. Moreover, the novelty items such as cocoon bird swings and dream catchers introduced innovative dimensions to cocoon utilization, moving beyond traditional garlands and religious decorations. This innovation-oriented approach is crucial in sustaining consumer interest, particularly in urban and tourism-driven markets.

3.2 Durability and Storage Stability

Durability is an essential parameter determining the long-term acceptance of handicrafts in domestic and export markets. In the present study, all cocoon bio-craft items retained their structural integrity and colour vibrancy for at least 12 months under ambient storage conditions. The sheen of the cocoons was preserved, and no visible deterioration in shape or texture was observed. This can be attributed to the careful dyeing and shade-drying process, which reduced the risk of photodegradation and colour fading.

Earlier research by Kaul & Pandey (2014) highlighted that exposure to high temperatures and direct sunlight accelerates pigment breakdown in silk fibers. In contrast, shade drying maintains fibre quality and extends product shelf life. The present findings are consistent with this observation, emphasizing that low-cost yet effective storage and drying techniques can significantly enhance the longevity of bio-crafts. Such durability is critical in ensuring customer satisfaction, especially when these items are purchased for long-term decorative purposes or ceremonial functions.

3.3 Economic Feasibility

The cost–benefit analysis of each product is presented in Table

Table 1. Cost–benefit analysis of cocoon craft items

Craft Item	Cocoons Required (per unit)	Total Cost (Rs.)	Sale Price (Rs.)	Net Profit (Rs.)
Cocoon flower vase	60–70	100	250	150
Cocoon wall hang	30–35	50	200	150
Cocoon bird swing	12–14	45	200	155
Single flower garland	80–85	60	100	40
Flower “bunch” garland	400–500	205	450	245
Cocoon pose (thoranam)	55–60	75	150	75

Among all products, the flower “bunch” garland yielded the highest net profit (Rs. 245), followed by cocoon bird swing (Rs. 155) and cocoon flower vase (Rs. 150). Although the single flower garland produced the lowest net profit (Rs. 40), its low material cost and fast production time make it an attractive option for bulk sales during festive seasons.

These results align with other researchers, who reported that diversification of sericulture by-products into high-demand handicrafts significantly enhances profitability for rural artisans. The present study also supports Bukhari (2024), who highlighted that small-scale cocoon craft enterprises can provide supplementary income for underemployed rural women.

3.4 Cultural Relevance and Aesthetic Appeal

The incorporation of cocoons into craft items resonates strongly with cultural traditions in sericulture-practicing regions of India. Products such as cocoon garlands, thoranams, and wall décor items carry cultural symbolism and are frequently used during weddings, festivals, and religious events. Unlike perishable floral decorations, cocoon garlands retain their freshness-like appearance for years, offering a sustainable and cost-effective alternative. This aspect reinforces the role of cocoon crafts in preserving intangible cultural heritage while adapting to modern consumer needs.

Anthropological studies on Indian handicrafts have emphasized that the success of traditional crafts depends on their ability to balance cultural authenticity with contemporary design trends. The vibrant colours of dyed cocoons align with the festive preferences of Indian consumers, while novel adaptations such as dream catchers reflect global cultural assimilation. This dual orientation ensures both domestic cultural acceptance and export potential.

3.5 Market Potential and Sustainability Dimensions

From an economic perspective, the production of cocoon bio-crafts demonstrated strong profitability, with estimated margins of 40–55% depending on product type and complexity. The raw materials, primarily pierced or cut cocoons, are otherwise considered waste in silk reeling industries. By transforming this waste into value-added products, artisans not only reduce environmental load but also generate sustainable income streams.

This aligns with the concept of circular economy, wherein by-products of one industry are reintroduced into the market as raw materials for another, thereby reducing waste and enhancing sustainability (Geissdoerfer *et al*., 2017). The eco-friendly character of cocoon crafts also caters to the growing consumer demand for sustainable lifestyle products, particularly in the global handicraft and tourism markets. The adaptability of cocoon crafts to e-commerce platforms further enhances their scalability. Researcher noted that digital platforms provide rural artisans with direct access to customers, significantly increasing income opportunities. Integrating cocoon craft enterprises into such online marketplaces can therefore expand their consumer base beyond regional limits

3.6 Comparative Insights and Future Prospects

The present findings are consistent with earlier reports emphasizing the role of silk-based crafts in rural livelihood sustainability. Sharma *et al*. (2022) reported that consumer preference for handicrafts is strongly influenced by innovation, durability, and cultural relevance, all of which were evident in the cocoon products developed in this study. Furthermore, the positive durability outcomes reinforce the conclusions of Kaul & Pandey (2014), highlighting the significance of processing techniques in maintaining silk fibre quality.

Looking ahead, further research could focus on integrating natural dyes into cocoon craft production, which would enhance the eco-friendly profile of the products and cater to health-conscious consumers who are increasingly wary of synthetic colourants. Additionally, collaborations between design institutes and sericulture farmers could promote innovative craft designs tailored for global markets. As highlighted by Bukhari (2024), innovation-driven craft clusters have a higher probability of sustaining long-term growth when supported by skill development and entrepreneurial training

(a) Cocoon flower

(b) Cocoon flower vase

(c) Cocoon wall hang

(d) Cocoon dream catcher

(e) Cocoon bird swing

(f) Single flower garland

(g) Flower "bunch" garland

(h) Cocoon pose/thoranam

Plate 1 (a-h). Cocoon-based handicrafts prepared from cut and pierced mulberry silkworm cocoons

4. CONCLUSION

The present study demonstrates that silkworm cut and pierced cocoons, often considered waste from grainage operations, can be effectively transformed into a variety of durable, aesthetically appealing, and marketable bio-crafts. Eight distinct products including cocoon flowers, flower vases, wall hangings, dream catchers, bird swings, single flower garlands, flower "bunch" garlands, and traditional cocoon pose (thoranam) were successfully fabricated using simple tools, dyed cocoons, and locally available decorative materials. Economic analysis revealed that the flower "bunch" garland generated the highest profit margin, followed by cocoon bird swing and cocoon flower vase, while lower-cost, quick-production items such as single flower garlands and wall hangings offered rapid turnover potential. The fabrication process proved to be cost-effective, eco-friendly, and culturally significant, with strong potential for rural entrepreneurship, particularly for women and underemployed households. By combining traditional craft skills with innovative product design, cocoon bio-crafting can enhance income generation, reduce sericulture waste, and contribute to sustainable rural livelihoods. Wider adoption of this practice, supported by training programs, market linkages, and product diversification, can strengthen the economic viability of the sericulture sector while preserving cultural heritage.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) or text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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