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Blooms beyond beauty: Commercializing floral waste for a sustainable city

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Abstract

The present research investigates the commercialization possibilities of floral waste in order to generate economic opportunities. When attractive blooms die, they change into a rich resource stream, providing environmentally favourable solutions. Current garbage disposal methods contribute to environmental damage, necessitating a move towards sustainable solutions. Researchers investigate the social, environmental, and economic implications of commercialising floral wastes using interviews, surveys, and field observations. The findings reveal a variety of waste streams--discarded flowers, leaves, and other plant remnants, each with potential for items such as organic fertilisers, natural dyes, and artisanal craft. Economic viability analysis emphasises the financial feasibility of this change, whereas social and environmental implications highlight job creation, biodiversity conservation, community empowerment, and waste reduction. Challenges like as commercial acceptability and technological limits are handled with inventive solutions, ensuring a greener, more prosperous future. This study proposes the reimagining of floral wastes as economic assets, promoting sustainability in the country's cultural and ecological fabric.

Keywords: Floral waste, commercialisation, livelihood, sustainability, waste reduction

1. Introduction

India's diverse environment allows for the natural growth of a vast range of floral species, which are often employed as decorations in temples on various occasions. Temples hold a variety of religious rites in which sweets, leaves, edible and non-edible fruits, garlands, flowers, and other items are offered to Gods (Samadhiya *et al.*, 2017) ^[17]. The waste collected from the temple comprises both biodegradable and non-biodegradable items, with floral waste being separated because it is biodegradable. A large amount of flower waste is generated in religious sites such as temples, cathedrals, and dargahs because flowers are offered to Gods in practically all religions as part of religious beliefs and then discarded (Yadav *et al.* 2015) ^[24]. When compared with kitchen garbage disposal, floral debris lacks adequate treatment solutions (Jadhav *et al.*, 2013) ^[9]. Improper disposal of flower debris in open landfills can pose a variety of health risks. After a few weeks of disposal, microbes decompose the flower waste, generating toxic gases. The gases involved include methane (CH₄), ammonia (NH₃), carbon dioxide (CO₂), and others, which cause foul odour and contribute significantly to greenhouse gas emissions (Singh *et al.*, 2021) ^[2]. Dumping floral debris into bodies of water endangers aquatic ecosystems. Such waste disposal procedures have a substantial impact on the diversity of aquatic organisms such as fish, diatoms, protozoans, molluscs, and plankton.

Pesticides and artificial fertilisers used in flower production, on the other hand, affect the pH of water bodies, causing aquatic life to suffer. Rotting flowers promote algal growth in water bodies, causing widespread eutrophication. Increased organic load in the water body caused by floral waste disposal may promote the growth of hazardous weeds and microorganisms, eventually diminishing oxygen availability (Makhania & Upadhyay, 2015) ^[13]. Aside from that, flower waste disposal can clog local drainage and water canals that link to such rivers. As the human population grows, so does the number of visitors, contributing to the massive amount of flower waste produced (Samadhiya *et al.*, 2017) ^[17].

Most Indian holy cities, including Haridwar, Shirdi, Kedarnath, Katra, Tirupati, Bhubaneswar, Varanasi, Patna, Gaya, and others, still have insufficient floral waste disposal policies in place. As a result, the disposal of floral debris in Indian temples has become a source of pollution to the environment (Echavarria-Alvarez & Hormaza-Anaguano, 2014) ^[4]. It is believed that about 40 percent of overall flower production in India and Sri Lanka goes unsold and discarded.

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Dumping floral waste on pavement and open spaces gives an area a filthy appearance and affects its image, particularly in areas considered key destinations for travellers (Waghmode *et al.*, 2018) [23]. Flower debris may contain a considerable amount of lignocellulose, making it a useful material for producing bioenergy such as biogas, biohydrogen, biocharcoal, bioethanol, or direct burning to generate heat energy. There is a pressing need to investigate the possibility of creating floral waste from temples as a fuel for energy production.

Flowers' fascination goes beyond beauty; their remains can be utilised in useful items. The present research seeks to elucidate the numerous aspects of commercialising floral wastes, including the current status of floral waste management, prospective product streams, financial sustainability, and the varied effects on society and the environment. By encouraging a broader understanding regarding the commercialization potential of floral wastes, the researchers hope to make a contribution to sustainable practices and towards a more resilient and eco-conscious future.

2. Literature Review

In the framework of the circular economy, Selvi & Atheswari's (2022) [18] research emphasises the importance of floral waste in material loop closure. Floral waste commercialization meshes with broader sustainability aims by converting waste into useful products, providing a comprehensive alternative to the linear paradigm of resource consumption. Scholars such as Bhati, Dubey, & Singh (2021) [2] have emphasised the economic value of reusing flower waste. Trivedi's (2021) [21] study highlights how entrepreneurial initiatives focused on floral waste-derived products help to create jobs and promote local economies. Waghmode, Gunjal, Nawani, & Patil (2018) [23] investigated the environmental implications of traditional flower waste disposal. On the contrary, the research by Hajam, Kumar, & Kumar (2023) [8] shows how commercialising floral wastes may significantly decrease carbon footprints and promote a circular economy. Technological improvements play an important role in the successful commercialization of flower waste. Innovations such as essential oil extraction techniques (Mathew, Anvitha, Sushmitha, & Rajeev, 2015) [14] and bioconversion processes (Gorasiya & Faldu, 2022) [7] have been investigated, demonstrating the possibility of scalable and sustainable production methods. Hajam, Kumar, & Kumar (2023) [8] address the social ramifications of flower waste commerce, with a focus on promoting community growth and empowerment.

Waghmode, Gunjal, Nawani, & Patil (2018) [23] explore the subtle aspects of floral-generated waste, disposal techniques, and the possibilities for cross-cultural information exchange. Researchers such as Petrou & Lacovidou (2015) [16] investigate the influence of policy and regulatory frameworks in defining the landscape of floral waste commercialization. Understanding the legislative consequences and potential incentives for firms and entrepreneurs is critical to fostering an enabling environment. Forsman & Madsen (2017) [6] investigated consumer perceptions regarding floral waste-derived goods, offering light on the dynamics of the market and potential barriers to general acceptance. Customer preferences and awareness are critical factors in determining the viability of commercial endeavours in this arena. Scholars

such as Srivastav *et al.* (2023) [20] investigate the problems that floral waste commercialization programmes confront, including market acceptance, legal frameworks, and logistic hurdles. Lessons from failed endeavours can provide significant insights into prospective endeavours.

3. Methodology

The present research uses a mixed-methods technique, which combines primary and secondary data sources. Primary data is acquired through interviews and surveys with stakeholders associated with floral waste production and commercialization. Secondary data consists of a thorough assessment of existing literature, case studies, and statistical reports, which provide an adequate platform for analysis and insights.

4. Discussions

Floral waste streams contain a vast amount of undiscovered resources, including botanical leftovers from events, marketplaces, and religious institutions. Understanding these varied streams is critical for realising the economic and environmental possibilities of floral waste. The majority of floral waste is made up of abandoned flowers that have wilted or withered and are therefore unfit for sale or display. These organically rich blooms can be recycled into a variety of valued goods. Beyond flowers, leaves and other plant remnants make important contributions to floral waste streams. Despite their appearance, these components contain vital chemicals that can be used in a variety of applications.

4.1. Potential Products

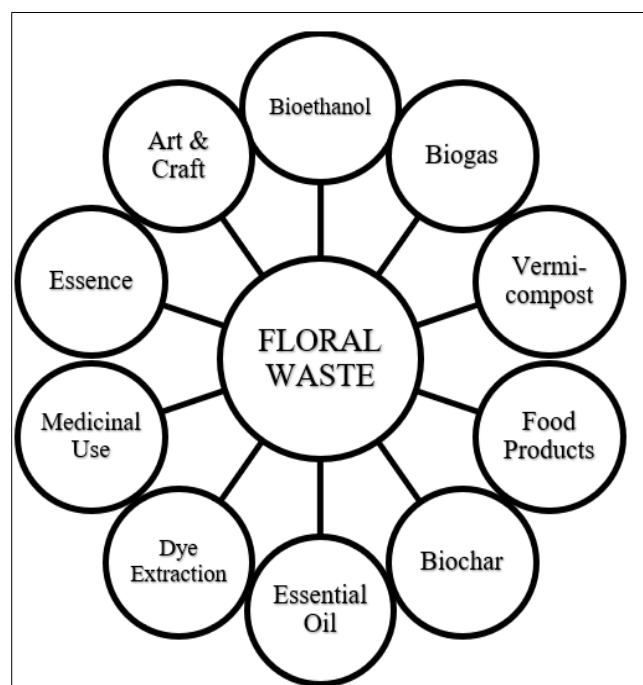


Fig 1: Potential products from Floral Waste

- Bioethanol:** Bioethanol created from floral waste can be combined with other fuels to boost energy efficiency, giving an eco-friendly strategy for reducing carbon footprint (Waghmode *et al.*, 2018) [23]. Saccharification of the reducing sugars derived from flower debris could result in a promising output of bioethanol and methanol.

2. **Biogas:** Flower waste can also be used to generate biogas through anaerobic digestion technology (Lakshmi & Vijayalakshmi, 2017) ^[12]. The biogas developed from floral waste can be utilised for cooking food or to generate energy (Kulkarni & Ghanegaonkar, 2019) ^[10].
3. **Vermicomposting:** Being abundant with organic matter, floral debris can be transformed into organic manure using specific earthworm species as a replacement for chemical fertiliser. Such vermicompost may aid in nutrient conditioning of the soil (Sharma & Yadav, 2017) ^[19]. Flower degradation material can be utilised as NPK fertiliser since it contains a higher concentration of nitrogen, phosphorous, and potassium.
4. **Food products:** Edible waste flowers, including roses and marigolds, are high in nutrients and can be used by food industries to make cakes, syrups, ice creams, biscuits, beverages, jellies, jams, candies, and other products (Waghmode *et al.*, 2018) ^[23].
5. **Biochar:** The woody component of flower waste can be turned into biochar via slow pyrolysis (Bogale, 2017) ^[3]. Biochar can also be used to absorb or adsorb heavy metals and other hazardous chemicals, hence purifying wastewater (Waghmode *et al.*, 2018) ^[23].
6. **Essential oil extraction:** Approximately 3,00,000 metric tonnes of flowers are used in India for a variety of reasons, including garlands, decorations, pigment extraction, pesticides, and perfume compounds. The flowers offered to deities can be found as temple flower waste, with roses accounting for 50 percent, and can be used to extract essential oils. Rose oil contains around 300 components (Perumal *et al.*, 2012) ^[15].
7. **Dye extraction:** Coloured pigments in flowers provide a distinct colour that draws the viewer's attention. The pigments from coloured flowers are extracted and used for a variety of applications, including:
 - Used for dyeing cloth in the textile business.
 - Create colourful candles.
 - Used in the food industry to colour eggs and vegetables.
 - Utilising sun dryers to create powdered colours for Holi and Rangoli. These colours are organic and safe to use (Kumar *et al.*, 2016) ^[11].
8. **Medicinal uses:** Certain flowers derived from temple flower waste, such as marigold and Hibiscus rosa sinensis, have medicinal characteristics and can be used for medicinal purposes, which are typically administered in the form of a decoction (Voon *et al.*, 2011) ^[22].
9. **Essence:** Essence can be obtained from flowers. These are infusions prepared from boiled flowers; there is no physical portion of the flower. Flower essence has extensive utility it can be used in cosmetic products, lotions, shampoos, aromatherapy, etc. (Ali *et al.*, 2015) ^[1].
10. **Miscellaneous uses:** Waste flowers are used to make incense sticks and handmade paper; also, dried flowers can be used in a variety of arts and crafts endeavours. Some flowers can be used as animal feed. Nowadays, activated carbon is produced from temple flower waste, which has a wide range of applications due to its adsorption capabilities (Elango & Govindasamy, 2018) ^[5]

4.2 Economic Viability

The financial sustainability of commercialising floral waste is a complex factor that includes manufacturing costs, consumer demand, and revenue opportunities. Analysing these characteristics is critical for determining the financial viability and sustainability of initiatives aimed at repurposing flower waste.

1. **Production Costs:** Evaluating the costs of collecting, processing, and transforming floral waste is critical. This comprises expenses for transportation, labour, technology, and any necessary infrastructure for productive waste conversion.
2. **Market:** Understanding the market for products made from flower waste is crucial. Market research to identify customer preferences, trends, and possible acceptance of sustainable and environmentally friendly items sheds light on market dynamics and commercial viability of floral waste products.
3. **Revenue Streams:** Identifying sustainable revenue streams is crucial for economic sustainability. This entails researching numerous markets, including agriculture (organic fertilisers), cosmetics (essential oils), and handcrafted products. Diversifying products and income streams can help to build financial resilience.
4. **Funding Mechanisms:** Startups and projects attempting to commercialise floral waste must consider funding options. This involves looking for grants, collaborations, or investment possibilities that are consistent with the venture's commitment to sustainability and the environment.
5. **Incentives and Policies:** Evaluating existing incentives and legislation for sustainable behaviours and reducing waste can greatly affect economic viability. Government initiatives, tax breaks, and subsidies for environmentally responsible firms can all help floral waste commercialization programmes succeed financially.
6. **Return on Investment (ROI):** Assessing projected ROI is crucial for determining economic viability. This entails predicting the financial returns against the initial expenditure while considering both long- and short-term perspectives.

4.3 Social Impacts

1. **Employment Possibilities:** Floral waste commercialization programmes can create jobs in the collecting, processing, and manufacturing phases. This promotes local economic growth and strengthens communities by generating long-term livelihoods.
2. **Community Engagement:** Involving local communities in floral waste projects promotes ownership and pride. Collaboration in rubbish collection or product development strengthens social cohesion and fosters a collective dedication to environmental sustainability.
3. **Empowerment of Marginalised Groups:** Floral waste projects can help women and minorities gain access to job and entrepreneurial opportunities. This social inclusion helps to promote societal equity.

4.4 Environmental Impacts

1. **Waste Reduction:** Minimising waste from flowers in landfills is a significant environmental advantage. By recycling wasted flowers and botanical remains, these initiatives help to reduce total waste and promote a

circular economy.

2. **Carbon Footprint Reduction:** Using floral waste to produce organic fertilisers and eco-friendly products can lessen the need for chemical alternatives. This reduces the carbon footprint related to standard agricultural and industrial activities.
3. **Biodiversity Conservation:** Sustainable floral waste management promotes biodiversity conservation. Preserving different plant species and ecosystems becomes critical, as several floral waste programmes may require the protection of certain plant varieties.
4. **Educational Opportunities:** Initiatives focused on flower waste can raise awareness about trash reduction, conservation of the environment, and sustainable living practices. This knowledge transmission promotes a culture of environmental concern.
5. **Enhanced Aesthetics and Well-being:** Recycling flower waste for community landscaping efforts like community gardens or green spaces improves the aesthetics of urban environments and promotes well-being. This, in turn, improves inhabitants' well-being by creating visually appealing spaces.

4.5 Challenges

1. **Market Acceptability:** Obtaining market acceptability for products made from floral waste might be problematic given consumer preferences for traditional alternatives.
2. **Technological Constraints:** Smaller-scale initiatives having limited resources may face challenges in implementing advanced waste conversion technologies.
3. **Regulatory Compliance:** Meeting environmental and industry requirements can be challenging when managing waste and commercialising products.
4. **Logistical Challenges:** Transporting floral debris from several sources to recycling facilities can be complicated, leading to increased operational expenses.

4.6 Solutions

1. **Consumer Marketing and Education:** Implement customer outreach and marketing efforts to promote the ecological advantages as well as the quality of floral waste-derived products. Effective marketing methods can help increase product adoption.
2. **Research and Development:** Investment in research and development to overcome technological limits. Collaboration with research universities can result in innovations that simplify procedures, rendering them more accessible and cost-effective.
3. **Stakeholder Collaboration:** Work with regional governments, environmental institutions, and industry partners to address regulatory obstacles. Proactive participation guarantees compliance while lobbying for policies that promote sustainable activities.
4. **Decentralized Processing Centers:** Establish decentralised processing centres near waste generation sources. This decreases transportation obstacles, and expenses, and increases the efficiency of garbage collection and processing operations.
5. **Community Involvement:** Encourage involvement in the community through awareness campaigns, incentive-based rubbish collection efforts, and participatory decision-making. Engaging local communities boosts support and alleviates logistical problems.

5. Conclusion

The commercialization of floral debris appears as a revolutionary opportunity with the potential to combine environmental concerns with economic feasibility. The investigation into this subject demonstrates the multidimensional character of floral waste, which includes several streams and prospective products. The economic analysis demonstrates the viability of repurposing floral waste, but problems in consumer acceptance, technology, and legislation remain. Considering floral waste as an important asset rather than a consequence creates potential for sustainable methods. The social consequences, including job creation and community development, highlight the potentially transformative effects of floral waste projects. Simultaneously, the favourable environmental consequences, such as trash reduction and carbon footprint reduction, are consistent with overall sustainability goals.

However, obstacles in market adoption and regulatory compliance demand collaborative efforts in outreach to consumers, technological innovation, and stakeholder engagement. Overcoming these obstacles necessitates a dedication to research and development, involvement in the community, and adaptive tactics. In managing the commercialization of floral waste, stakeholders must strike a delicate balance between economic growth and environmental responsibility. This study proposes a comprehensive approach that acknowledges the interdependence of economic, social, and environmental factors. Floral waste commercialization can only thrive with collaborative efforts, novel approaches, and a shared dedication to sustainability, resulting in a greener and more economically durable future.

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