Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Spl Issue [2] 2023: 555-562.

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

REVIEW ARTICLE **OPEN ACCESS**

Sustainable Management of Floral Refuse from Temples: A Review

Aruna Saini[1] and Shelja.K.Juneja[2]
1-2 Department of Life Science & Environmental Science
IIS (Deemed to be University), Mansarovar, Jaipur Rajasthan
Email address for correspondence*: sainiaruna0@gmail.com

ABSTRACT
In India, the practice of religion permeates daily life, with devotees offering a variety of items to the Gods, predominantly flowers such as roses, jasmine, marigolds, chrysanthemums, hyacinths, hibiscus, and more. Flowers, revered as symbols of devotion and respect, play a significant role in religious ceremonies and festivities at temples and various locations. However, the substantial amounts of floral waste generated daily pose environmental challenges when disposed of in open dumps or released into aquatic bodies, resulting in unpleasant odours. These sites also serve as breeding grounds for pathogenic microorganisms, further compromising water body ecosystems and causing severe pollution, leading to the loss of aquatic life. To address the issue of improper disposal, there is a potential for sustainable utilization of discarded flowers through various processes, including vermicomposting, dye manufacturing, biogas generation, herbal gulal, incense sticks, and essential oils. These methods aim to prevent the adverse environmental impact of flower waste and contribute to more responsible waste management practices. Implementing such approaches not only mitigates pollution but also promotes a greener and more sustainable environment. By adopting these practices, temples have the opportunity to enhance their artistic and commercial aspects, fostering a dual benefit of cultural enrichment and economic viability. Moreover, embracing sustainable methods ensures that temples contribute positively to environmental conservation, aligning with the principles of being more eco-friendly and sustainable.
Keywords: flower waste, incense sticks, holi colour

Received 02 .11.2023 Revised 05.12.2023 Accepted 12.01.2024

INTRODUCTION

The primary drivers of environmental deterioration include the exploitation of natural resources, industrialization, urbanization, and a growing population. As the population increases and development progresses, pollution intensifies, adversely affecting the air, water, and land. The harmful impact on both the environment and human health results from various forms of pollution, including solid waste and its disposal methods [1].

Waste encompasses items that individuals no longer use and intend to discard or have already discarded. It includes materials that people need to dispose of, and every human action generates garbage, contributing to the degradation of human health standards and harm to the ecosystem [2]. The term "solid waste" covers a wide range of materials, such as solid or semi-solid domestic waste, sanitary waste, commercial waste, institutional waste, street sweepings, horticulture waste, agriculture and dairy waste, and treated bio-medical waste, among others. Even seemingly harmless waste, such as temple flower waste, is a concern for temple management [3].

Garbage not only poses environmental challenges but also creates significant issues in economically developing countries, where proper waste management is a complex task. India, as a developing nation, faces challenges in waste disposal, and viable solutions are yet to emerge. The investigation into efficient waste management is crucial, especially considering the potential utilization of waste in industrial processes and electricity generation. However, managing garbage today is a complex task due to various limiting factors, making it widely accepted that effective waste management is essential for preserving natural resources, protecting health, and safeguarding the environment [4].

In India, worship is deeply ingrained in the way of life, and as part of these rituals, devotees offer flowers, leaves, fruits, coconuts and clothing to the gods. The practice extends across various religious institutions, including temples, churches, mosques, and gurudwaras, generating an estimated 800 million tonnes of floral waste, encompassing marigolds and roses. This waste also originates from hotels, weddings, gardens, and various cultural and religious ceremonies, contributing to a significant environmental concern [5].

During rituals and festivals, temples in India, adorned with various flowers, face a challenge in handling the resulting waste. The waste primarily comprises organic materials such as flowers, leaves, coconut shells, and incense stick residues, which often end up in bins or water bodies, leading to pollution and hygiene issues. The disposal of floral waste becomes particularly pronounced during major festivals and religious rituals in cities known for their places of worship [6].

Floral waste, including offerings like jasmine, marigold, chrysanthemum, China rose, and roses, are often discarded into rivers and seas, causing environmental damage and disrupting aquatic ecosystems. This disposal method, widespread across various venues such as hotels, wedding gardens, and religious sites, contributes to water pollution, affecting the food chain and life cycles of aquatic organisms [7].

India's numerous temples and mosques, with their substantial floral waste, pose a challenge in waste management due to the foul odours generated during degradation, impacting the land, water, and air. This pollution, alongside the release of toxic substances from pesticides and fertilizers used in religious activities, further endangers human health and disrupts ecological cycles [8].

Annually, over 8 million tonnes of temple waste, including flowers, toxic pesticides, and insecticides, find their way into water bodies, creating imbalances and harming aquatic life. Despite the magnitude of the issue, floral pollution remains overlooked compared to industrial pollution. Many temples generate up to 20 tonnes of floral garbage daily, contributing to landfills and preventing decomposition, ultimately harming the environment [9].

The impact of floral waste extends beyond India, with Sri Lanka also losing a significant portion of its floral yield daily. This waste not only pollutes the ecosystem but also affects water supplies when left on land or thrown into water. To address this issue, there is a growing awareness of the potential for using floral waste to create sustainable products, such as herbal incense sticks, herbal colours, natural dyes, soaps, perfumes, and more [10].

Efforts to repurpose floral waste have resulted in the creation of various value-added products, including compost, biofuels, bioethanol, organic acids, pigments, dyes, food items, biosurfactants, sugar syrup, incense sticks, and handmade paper. This approach not only mitigates the environmental impact of floral waste but also provides avenues for sustainable product development [11].

Highlighting the specific case of Jaipur, where temples generate substantial floral waste, the environmental and health risks associated with improper disposal become evident. Similarly, in Varanasi, the proximity to the Ganges results in the dumping of floral waste into the river, causing harm to the ecosystem and emitting unpleasant odours [12];[13];[14].

The present paper has reviewed various techniques that are eco-friendly with zero hazardous effects on the environment and human health reported for the sustainable utilization of floral waste from different sectors to ensure that flower waste is processed productively.

Temple Floral Waste Management

The ethical use of temple garbage can positively affect the environment and the economy. The waste generated in temples is segregated into biodegradable and non-biodegradable waste. Biodegradable part is used in making compost from temple debris that yields organic manure which can be utilised to boost agriculture productivity and soil fertility. The incense sticks and natural colours prepared from flower waste can be sold as eco-friendly goods, bringing in more money for temples all around the country. For instance, the waste from flowers is utilized to create herbal soaps, incense sticks, and natural dyes, whereas the trash from food is fed to animals. Additionally, some temples have put advanced waste management techniques into practice, including biogas plants, vermicomposting, and power generation from waste-to-energy facilities that are utilized to light the temple and the area around it.

Vermicomposting

Vermicomposting technology stands out as a highly effective approach to mitigating global environmental pollution issues. This waste management method treats organic residuals as a valuable resource, avoiding burning or landfilling. Vermicompost, produced through vermicomposting, replaces chemical fertilizers, aligning with environmentally sound principles emphasising resource conservation and sustainable practices [15]; [16].

Vermiculture technology involves specific earthworm species expediting the conversion of waste to vermicompost, a superior humus-like product. Operating at temperatures from 10°C to 32°C, vermicomposting utilizes earthworms and microorganisms, facilitating a faster process than traditional composting. The resulting earthworm castings boast microbial activity, plant growth regulators, enhanced soil fertility, and pest-repelling properties [17].

Vermicomposting requires space, cow manure, organic waste, and specific earthworm species. Components like cattle dung, sheep droppings, biogas slurry, crop stubble, corn husks, kitchen and garden waste, temple waste, and festival leftovers are among the organic materials used for vermicomposting [18].

The absorption of macro- and micronutrients in vermicompost enhances plant nutrition, growth, photosynthesis, and chlorophyll content, offering benefits to farmers highlight the potential for vermicompost to substitute chemical fertilizers, thereby increasing the value of organic products and benefiting end consumers like farmers [19]

Various sustainable practices are implemented in different regions for the preparation of vermicompost from floral waste, a study conducted in Jaipur city temples to explore the use of vermicomposting in managing floral waste. They produced vermicompost beds using a mixture of marigold and cow manure in various ratios, finding that a 60:40 ratio resulted in a higher proportion of vermicompost to garbage. The study concluded that combining floral waste with cow dung in ratios of 50:50, 60:40, and 70:30 could yield nutrient-rich vermicompost [20]

In another study, using floral waste and cow dung to create vermicompost suitable for *Eudrilus eugeniae*. They examined the effects of adding *Trichoderma harzianum* powder to expedite the breakdown of floral debris. The study suggested that vermicomposting floral waste in an environmentally benign way is achievable by combining equal parts of cattle manure and *Trichoderma harzianum* powder [21]

Employed vermicomposting to manage temple waste, collecting a mixture of cow dung and floral waste. *Eisenia foetida* earthworm species were used to prepare the vermicompost, and the experiment, covered with garden soil, evaluated different vermicompost concentrations (50:50 and 70:30) in pot culture. The observed enhanced growth of rose plants compared to the control led to the conclusion that vermicomposting from flower waste is among the most effective methods for temple waste management [22].

Used temple flower waste extract to create a microbiological nutrient medium for culturing bacteria (pH 7.4) and fungus (pH 5.4). They developed microbial consortia for the breakdown of floral waste using the floral waste media, with results showing the enrichment of mature compost with nitrogen, phosphorus, potassium, calcium, and magnesium, supporting the growth of tomato plants [23].

Evaluated the survival of earthworms and decomposition of temple waste, considering different combinations of temple floral waste, cattle dung, leaves and *Trichoderma viride* as the best possible method for vermicomposting [24].

In a study, the collection, handling, utilization, and management of waste flowers from temples were described. The study aimed to recycle used flowers into compost, biogas, incense sticks, dye, and other products through the vermicomposting process, utilizing *Eisenia foetida*, an Earthworm species, to manage flower debris mixed with cow manure. The study's conclusions were encouraging, highlighting the potential of using leftover temple floral waste for useful, environmentally friendly applications [25]

Biogas production

The anaerobic digestion or fermentation of organic materials leads to the generation of gas. Biogas, an excellent energy source, is formed as bacteria decompose organic waste, including garbage and sewage, particularly in the absence of oxygen. Comprising primarily of 60% methane and 40% carbon dioxide, biogas is characterized by its tasteless, colourless, and odourless properties, resulting in a cleaner burn compared to other fuels. This gas can be stored and utilized for cooking and heating [26]. Various sources, such as manure-producing farms (e.g., hog and dairy farms), agricultural and forestry waste, organic industrial and temple waste, and animal manure, can be harnessed to produce biogas. Notably, temple floral waste has the potential to generate biogas, offering an organic material with high calorific content and nutritional value for bacteria, thereby significantly enhancing methane production efficiency [27].

Numerous studies have highlighted the sustainability of generating energy from floral waste produced by temples through the production of biogas.

In a study, temple waste served as the feedstock for an anaerobic digester system, yielding biogas energy. The anaerobic digestion process of temple waste produces biogas, a valuable energy resource, through microbial fermentation involving methane and carbon dioxide [28]

Reviewed various methods for utilizing temple waste, including floral waste, as a potential fuel or substitute material, such as wood, in the combustion process. This approach addresses disposal issues and reduces reliance on the current valuable fuel source, wood [29].

They explored different techniques, including novel alkaline pre-treatment, solar heating of the digester, and co-digestion with food waste, to enhance biogas production from floral waste. Their study employed sodium carbonate and sodium bicarbonate for pre-treatment, revealing a 106% improvement in biogas output with floral waste pre-treatment. Solar heating of the digester increased biogas output by 122%, and co-digestion with food waste resulted in a 32.6% improvement. Raw biogas from floral waste contained over 57% methane, indicating a significant methane content.[30]

Emphasized the potential for generating low-cost bioenergy from floral waste. They proposed various forms of bioenergy, including biogas, biohydrogen, bioethanol, biocharcoal, or direct burning for heat

energy, derived from floral waste disposal. The paper outlines practical outcomes and explores how floral waste can be leveraged as a cost-effective source of bioenergy. [31]

In a study conducted at GriyaAnyar Tanah Kilap Temple in Denpasar, Bali, waste was collected, segregated into biodegradable and non-biodegradable categories, and recycled into Refuse Derived Fuel (RDF). Leaf and flower waste were used as RDF material through natural drying and pyrolysis approaches.[32]

Dye extraction and Essential oils

Dyes are compounds utilized to impart colour to textiles, paper, leather, and other materials, ensuring that the colour remains resistant to changes induced by washing, heating, or various environmental conditions. To enhance the dye's permanence on the fibre, a mordant is commonly employed during the dye application process [33].

Natural dyes, derived from plant sources, possess high biodegradability, making them an eco-friendly choice. Their renewable origin and safer effects compared to synthetic colours contribute to their prevalent use in the textile industry. Textiles such as cotton, silk, and wool can be dyed using these natural substances, offering stable colours without skin allergens and posing no disposal issues due to their environmentally friendly attributes [34].

Various plant parts are employed in diverse colouring techniques, providing a range of options for safe and sustainable dyeing practices. Utilizing natural dyes for fabric colouring presents several advantages over synthetic dyes, including environmental friendliness, the potential for premium pricing, the ability to produce a variety of colours from a single dye source and the absence of risks to human health [35].

Numerous researchers have conducted experiments on the extraction of natural dyes from various flowers, and some of these studies are outlined below.

They focused on the extraction and analysis of essential oil from temple-offered roses (*Rosa damascena*) through steam distillation. The study identified jasmine, rose, marigold, and chrysanthemum in the temple flowers. The rose petals were separated, dried in the shade, and subjected to essential oil extraction. Chemical analysis of the rose oil revealed phenyl ethyl alcohol (23.19%) as the main component, followed by hexadecane (10.49%), octadecane (7.76%), phenyl ethyl tetra decyl ester (5.77%), and tetramethyltrisilocendecanol (3.45%). This study showcased the potential use of temple-offered *R. damascena* flowers for essential oil production. [36]

Conducted an experiment on the extraction of pigments, including flavonoids and carotenoids, from marigold flowers *(Tagetes erecta)* using the Soxhlet extraction method and Spectrophotometric technique. The extracted colourants were used to dye pure cotton fabrics and yarns of pure cotton and wool. [37]

Demonstrated the utilization of waste petals from *Rosa damascena* as a natural dye for chrome-tanned goat crust leather. The study utilized a Spectrophotometer for evaluating the colour coordinates of dyed substrates, highlighting *Rosa damascena* petals as a promising source of natural dye for eco-friendly leather dyeing [38].

Conducted notable research on the extraction of natural dye from the floral waste of *Aster chinensis*. The study also explored the use of the extracted dye as a pH indicator in acid-base titrations, presenting a practical and environmentally friendly alternative to synthetic pH indicators in titrimetric analysis.[39]

Employed fresh flowers like Red Rose, Hibiscus and Marigold to extract natural dyes for colouring the cotton fabric. Three distinct extraction techniques were utilized, and the cotton cloth was dyed using ferrous sulphate and copper sulphate as mordants, revealing a variety of hues from Red Rose, Hibiscus, and Marigold flowers [40].

Utilized colourants extracted from dried petals of Marigold (*Tagetes erecta*), pomegranate rind (*Punica granatum*), and parijat corolla (*Nyctanthesarbor-tristis*) for dyeing cotton and silk. This eco-friendly approach showcased the potential for commercial dyeing of cotton and silk using these natural sources.

Incense sticks

Incense, an aromatic biological substance that emits fragrant smoke when burned, is employed for ceremonial, religious, and therapeutic purposes. Its forms, such as sticks, coils, and cones, serve various functions. Incense sticks are commonly used in temples for religious rituals and are integral to worship practices across cultures. However, conventional incense sticks made with charcoal powder may release smoke containing submicron-sized particles, including ultrafine and nanoparticles, leading to adverse health effects [41].

To address this concern, herbal incense sticks have been developed using powders derived from different woods, barks, gums and volatile oils. These herbal incense sticks were crafted through a mold-based manufacturing process and assessed for their antibacterial properties. The study concluded that these herbal incense sticks could be effectively utilized for fumigating homes [42].

Utilized temple waste, comprising flowers and unused coconut shells from offerings, to create fragrant incense sticks. The manufacturing process considered various parameters to ensure suitability, cost-effectiveness, non-pollution, and ease for small-scale and household enterprises. While grinding florets was a straightforward process, coconut processing required more energy [43]. Conducted a case study on the sustainability awareness and social initiative led by Ankit Agarwal, an Indian entrepreneur. Agarwal's company, Phool, focuses on utilizing leftover temple flowers to produce fragrances and other products, marketing them nationally and globally.[44]

Identified the practice of crafting incense sticks from discarded marigold flowers, particularly during festivals like Navratri in Nasik, Maharashtra. These flowers, initially offered to deities, were often discarded into waterways after use. The study aimed to transform this waste into a useful, aesthetically pleasing, and value-added product by using dried marigold petals for incense stick production. The researchers suggested selling the finished items to support daily wage earners.[45]

Focused on the collection, processing, and utilization of waste flowers. The Tumakur temple generated a substantial daily amount of floral waste, often improperly disposed of in open areas or dustbins, eventually ending up in landfills with municipal solid waste. The researchers converted this waste into incense sticks to reduce trash at the shrine. Additionally, they studied the surface appearance and chemical contents of crushed flowers using SEM and EDS.[46]

Holi colour

Holi, an ancient festival symbolizing spring and harvest, is traditionally celebrated with bright colours such as green, red, silver, and purple. Unfortunately, these vibrant hues often contain harmful chemical substances like copper sulfate, mercury sulfite, aluminium bromide, and chromium iodide, leading to severe health effects including allergies, skin cancer, mental retardation, and respiratory issues.

To address this health concern, an eco-friendly alternative involves creating organic gulal, or dry colours, from flowers, contributing to responsible flower waste management. Pioneered a process for making herbal dry colours by blending natural dyes with specific natural components, ensuring good adherence to the skin without releasing toxic substances during preparation.

Established a cost-effective method for producing environmentally friendly "holi" powder using tapioca flour and a synthetic food colour permitted by the Fruit Products Order of 1955, free from heavy metals. The holi powder contained 0.365% of the active component, offering brilliant colours, a sticky feel, cost-effectiveness and ease of use. [47]

Investigated the particle sizes and potential pro-inflammatory responses of four distinct Holi colours. Using an electric field cell counting method, they studied cytokine production via ELISA and leukocyte oxidative burst via flow cytometric analysis. XTT ((2,3-Bis-(2-methoxy-4-nitro-5-sulfophenyl)-2H-tetrazolium-5-carboxanilide) and Propidium iodide cytotoxicity tests were conducted, and endotoxin levels in Holi colour samples were assessed using the Limulus Amebocyte Lysate (LAL) test. The study concluded that all tested Holi colours contained more than 40% of PM10 particles, with over 75% present in two of the studied Holi powders.[48]

The use of these hazardous Holi colours not only poses health risks but also has ecological implications, disturbing the ecological equilibrium due to their slow decomposition. The complexly organized polymers in these colours contribute to their resistance to natural degradation, harming rivers and soil when runoff occurs linked the high concentration of PM10 particles to documented adverse health consequences of Holi colours, emphasizing the potential for pro-inflammatory responses and oxidative leukocyte bursts.

Introduced an environmentally friendly extraction method, yielding more colouring components without extensive use of organic solvents. This method included techniques such as the aqueous technique, acidic technique, and alkaline technique for extracting natural colour from beets.[49]

In response to these concerns, opted for safe, natural, and environmentally friendly Holi colours, prepared with rice flour and natural colours obtained from tapioca plants, as a sustainable alternative to commercial chemical Holi colours [50]

Waste Management Practices at the community level in India:

Traditional temples in India have embraced eco-friendly waste management practices, contributing to sustainability efforts.

Shri Mahakaleshwar, a prominent Jyotirlinga temple producing 3 tonnes of organic waste, primarily flowers annually, became a focus for waste-to-energy conversion by [49]. Biomethane and vermicompost were created from food and floral remnants, exploring the potential of generating energy from temple waste.

Kashi Vishwanath Temple, witnessing a significant influx of devotees, has its dedicated waste disposal unit. The temple efficiently converts vast quantities of floral waste into fertilizer, promoting sustainable waste practices.

Gorakhnath Temple in Uttar Pradesh, under Chief Minister Yogi Adityanath's leadership, initiated the production of incense sticks from flower trimmings, showcasing the first step in floral waste recovery. The MahayogiGorakhnath Krishi Vigyan Kendra, a district-level agricultural science institute, was established to produce these incense sticks.

Ajmer Sharif Dargah implemented a rose water distillation facility, addressing flower waste concerns. With around 15 to 18 quintals of rose petals repurposed to manufacture rose essential water, the facility also provides employment opportunities for local women [50].

Temples in Pammal, Tamil Nadu, exemplify waste reduction efforts. Exnora Green Pammal (EGP), led by Mangalam Balasubramanian, established a bio-gas plant on temple grounds, recycling undesired flower debris, fruit waste, and other organic materials. The plant's leftover sludge serves as green manure in the temple garden.

Apart from temples, various enterprises and NGOs contribute to Floral Waste management:

Aaruhi Enterprise, initiated by Poonam Sehrawat, creatively utilizes floral debris to produce incense sticks free of charcoal. This venture empowers nearly 200 women, offering employment and training in flower processing [51].

Minal and Maya Vivek focus on recycling floral waste, collaborating with local women to craft environmentally responsible products. Their efforts provide livelihood opportunities and foster individual growth.

Help Us Green, founded by Ankit Agarwal and Karan Rastogi, pioneers floral cycling technology to prevent the Ganges River from becoming a dumping ground. Through vermicomposting and innovative products like Florafoam, they contribute to soil fertility, correct soil texture, and address environmental challenges. The Phool brand markets their eco-friendly products.

CONCLUSION

The responsible management and utilization of floral waste generated by various industries are emphasized in this study. The focus revolves around multiple strategies to transform floral waste into valuable products such as vermicompost, biogas, colors, incense sticks, herbal gulal, etc. The assertion is that when floral waste is disposed of securely and in an environmentally acceptable manner, it can be repurposed into useful products, contributing to eco-friendly waste management practices. These products include compost, beneficial for plant growth, biogas for energy generation, fragrant sticks, non-irritant holi colours, and other valuable items derived from recycled floral waste. Biofuels and bioethanol can address energy challenges, while dyes and pigments find applications in diverse textile industries. The sustainable management of residual flower waste holds the potential to create a cleaner and healthier environment for society.

REFERENCES

1. Yadav, I., Juneja, S. K., & Chauhan, S. (2015). Temple waste utilization and management: A review. *International Journal of Engineering Technology Science and Research*, *2*, 14.
2. Yadav, I. (2018). Sustainable utilisation of temple waste to promote green temple concept
3. Mishra, N. (2013). Unholy mess: temple waste: a concern. Times of India.
4. The Expert Committee, (2000) Manual on Municipal Solid Waste Management, The Ministry of Urban Development, The Government of India. 1(2), 789
5. Shivangi, S. C. (2021). Review Paper on-Ecofriendly Practice in Temple to Make Sustainable Approach toward Social and Environment. *Int. j. res. sci*, *6*, 2024-2454.
6. Ravishankar, R., Raju, A. B., Abdul, B. M., Mohpatra, A. K., & Kumar, M. (2014). Extraction of useful products from temple flower wastes. J ChemEng Res, 2(1), 231-239.
7. Neeraj Kumar, Navdeep Malhotra, & Bhaskar Nagar. (2017). Modelling and analysis of coconut shell grinding machine for utilization of temple waste for specific application as manufacturing of incense sticks/cones. *International Education and Research Journal (IERJ)*, *3*(6).
8. Anvitha, V., Sushmitha, M. B., Rajeev, R. B., & Mathew, B. B. (2015). The importance, extraction and usage of some floral wastes. *J Biotechnol Bioinform Bioeng*, *2*(1), 1-6.
9. Mulay, Y., Owal, S., Chougule, P., &Pandit, A. (2020). Composting of floral waste by using indigenously isolated microbial consortium: an approach towards the Environment sustainability and waste management. *Int J Environ Agric Res*, *6*(4), 20-26.
10. Recycling Flowers Empowers Rural Women (2013, January 13). The Hindu. Retrieved from www.thehindu.com Accessed 28 nov, 2023.
11. Nair, A., Kelkar, A., Kshirsagar, S., Harekar, A., Satardekar, K., Barve, S., & Kakodkar, S. (2018). Extraction of natural dye from waste flowers of Aster (Aster chinensis) and studying its potential application as pH indicator. *J Innovations Pharm BiolSci*, *5*(4), 1-4.
12. Padmavathiamma, P. K., Li, L. Y., &Kumari, U. R. (2008). An experimental study of vermi-biowaste composting for agricultural soil improvement. *Bioresource technology*, *99*(6), 1672-1681.

13. Wani, K. A., & Rao, R. J. (2013). Bioconversion of garden waste, kitchen waste and cow dung into value-added products using earthworm Eiseniafetida. *Saudi journal of biological sciences*, *20*(2), 149-154.
14. Murthy, P. S., & Naidu, M. M. (2012). Sustainable management of coffee industry by-products and value addition—A review. *Resources, Conservation and recycling*, *66*, 45-58.
15. Aalok, A., Tripathi, A. K., &Soni, P. (2008). Vermicomposting: a better option for organic solid waste management. *Journal of Human Ecology*, *24*(1), 59-64.
16. Kaur, T. (2020). Vermicomposting: An Effective Option for Recycling Organic Wastes. IntechOpen. doi: 10.5772/intechopen.91892
17. Sailaja, D., Srilakshmi, P., Shehanaaz, P. H., Bharathi, D. L., & Begum, A. (2013). Preparation of vermicompost from temple waste flower. *Int J SciInnoDiscov*, *3*(3), 367-375.
18. Singh, A., Jain, A., Sarma, B. K., Abhilash, P. C., & Singh, H. B. (2013). Solid waste management of temple floral offerings by vermicomposting using Eiseniafetida. Waste management, 33(5), 1113-1118.
19. Ahmad, A., Aslam, Z., Bellitürk, K., Ullah, E., Raza, A., & Asif, M. (2022). Vermicomposting by bio-recycling of animal and plant waste: A review on the miracle of nature. *Journal of Innovative Sciences*, *8*(2), 175-187.
20. Tiwari, P., &Juneja, S. K. (2016). Management of floral waste generated from temples of Jaipur city through vermicomposting. International Journal of Environment, 5(1), 1-13.
21. Samadhiya, H. (2017). A study on the Management of temple waste through vermicomposting and assessment of the quality of temple waste generated vermicompost.
22. Baria, D., Chauhan, R.S., &Popli, S.A. (2018). Temple Waste Management: A Case Study of Anand City.
23. Mulay, Y., Owal, S., Chougule, P., &Pandit, A. (2020). Composting of floral waste by using indigenously isolated microbial consortium: an approach towards the Environment sustainability and waste management. *Int J Environ Agric Res*, *6*(4), 20-26.
24. Kumar, r., hajam, y. A., &sharma, r. (2021). A study on decomposition of temple waste using fungal formulations and evaluating the survival rate of earthworms. *Asian Journal of Advances in Research*, *4*(1), 1143–1152.
25. Pal, V. &Pati, P. (2022). Utilization and enhancing the degradation of flower waste generated from temple. International Journal of Modernization in Engineering Technology and Science, 4(08)
26. Kumar, R.G., Nirmalraj, P., & Sabarinath, S. (2018). Biogas Production using Temple Waste. IJSRD - International Journal for Scientific Research & Development, 6(02), 871-873
27. Kulkarni, M. B., & Ghanegaonkar, P. M. (2019). Biogas generation from floral waste using different techniques. Global Journal of Environmental Science and Management, 5(1), 17- 30.
28. Kumar, R.G., Nirmalraj, P., & Sabarinath, S. (2018). Biogas Production using Temple Waste. IJSRD - International Journal for Scientific Research & Development, 6(02), 871-873
29. Raji, S., Sarodea, D. D., Gholapb, S., &Gangrudeb, S. (2018). Value addition to temple waste–A study. *J. Indian Chem. Soc*, *95*, 231-234.
30. Kumar, V., Kumari, S., & Kumar, P. (2020). Management and sustainable energy production using flower waste generated from temples. *Environmental degradation: causes and remediation strategies*, *1*, 154.
31. Wijaya, I. M. W., Wiratama, I. G. N. M., Putra, I. K. A., &Aris, A. (2023). Refuse Derived Fuel Potential Production from Temple Waste as Energy Alternative Resource in Bali Island. *Journal of Ecological Engineering*, *24*(4), 288-296.
32. Ramprasath, R., Kavi, G. G., &Rathi, T. S. (2017). Isolation of natural dyes from hibiscus Rosa sinensis and marigold flower and dyeing properties of the dyes on cotton cloth. *Journal of Applied Chemistry*, *10*(5), 74-79.
33. Jothi, D. (2008). Extraction of natural dyes from African marigold flower (*Tagetes erecta* L) for textile coloration. *Autex Research Journal*, *8*(2), 49-53.
34. Sanjeeda, I., &Taiyaba, A. N. (2014). Natural dyes: their sources and ecofriendly use as textile materials. *Journal of Environmental Research and development*, *8*(3A), 683.
35. Perumal, K., Moorthy, T.A., and Savitha, J.S. (2012) Characterization of Essential Oil from Offered Temple Flowers *Rosa damascena* Mill. Asian Journal of Experimental Biology and Science. 3 (2), 330-334.
36. Devi Rajeswari, V., Jha, C. K., Kumar, R., &Venkat Kumar, S. (2015). Extraction of natural dye from marigold flower (*Tagetes erecta* l.) and dyeing of fabric and yarns: A focus on colorimetric analysis and fastness properties. Der Pharmacia Lettre, 7(1), 185-195.
37. Pervaiz, S., Mughal, T. A., Najeebullah, M., & Khan, F. Z. (2016) Extraction of natural dye from *Rosa damascena* Miller: Cost effective approach for leather industry. International Network for Natural Sciences, Int. J. Biosci.8(6), 83-92.
38. Nair, A., Kelkar, A., Kshirsagar, S., Harekar, A., Satardekar, K., Barve, S., &Kakodkar, S. (2018). Extraction of natural dye from waste flowers of Aster (Aster chinensis) and studying its potential application as pH indicator. *J Innovations Pharm BiolSci*, *5*(4), 1-4.
39. Ansaria, S., Shaikha, F., Patela, K., Shaikha, F., Dodiyaa, D., Yadava, A., ...& Kelkarb, V. (2022). Extraction of natural dye from different flowers for dyeing cotton fabrics.
40. S. W., Balasubramanian, R., & Joshi, U. M. (2007). Physical characteristics of nanoparticles emitted from incense smoke. *Science and Technology of Advanced Materials*, *8*(1-2), 25.
41. Raut, A. B., Shah, A. N., Polshettiwar, S. A., & Kuchekar, B. S. (2011). Preparation and evaluation of antimicrobial herbal based incense sticks for fumigation against infectious bacteria. *Journal of Chemical and Pharmaceutical Research*, *3*(4), 707-712.
42. Neeraj Kumar, NavdeepMalhotra, & Bhaskar Nagar. (2017). Modelling and analysis of coconut shell grinding machine for utilization of temple waste for specific application as manufacturing of incense sticks/cones. *International Education and Research Journal (IERJ)*, *3*(6). 12-15

43. Deshpande, A. (2021). Sustainable Initiative of Worshiped Flower Waste and a Diverse Social Enterprise; "Phool. com". *PalArch's Journal of Archaeology of Egypt/Egyptology*, *18*(7), 2157-2164.
44. Saoji, R. Y., Zalte, A., &Guleccha, V. (2021). Preparation of Incense Stick using Marigold floral waste from Nasik region. *Journal of Pharmaceutical Sciences and Research*, *13*(10), 635-637.
45. Dasalukunte Ananda, K., &Halappa, K. (2023). Evaluation and conversion of temple waste flowers into incense sticks in tumakuru district of Karnataka, India. *The holistic approach to environment*, *13*(1), 10-21.
46. Das, P., Goswami, N., & Borah, P. (2015). Development of Low-Cost Eco-friendly 'Holi'Powder. *International Journal of Agriculture Innovations and Research*, *4*(3), 466-468.
47. Bossmann, K., Bach, S., Höflich, C., Valtanen, K., Heinze, R., Neumann, A., Straff, W., &Süring, K. (2016). Holi colours contain PM10 and can induce pro-inflammatory responses. *Journal of occupational medicine and toxicology (London, England)*, *11*(1), 42. https://doi.org/10.1186/s12995-016-0130-9
48. Tiwari, S. K. (2020). Extraction of natural dye and preparation of herbal gulal from beetroot (Beta vulgaris). *Journal of Pharmacognosy and Phytochemistry*, *9*(4), 3206-3211.
49. Basumatary, P., Bhuyan, M. K., Sarmah, P., &Saikia, D. (2021). Eco-friendly Holi using Natural Dye and Low-Cost Filler Base. *Int. J. Curr. Microbiol. App. Sci*, *10*(02), 1067-75.
50. Agarwal, S. (2011). Report on demonstration of renewable energy system at Shri Mahakaleshwar Temple Complex in Ujjain. *Ministry of New and renewable energy, New Delhi, pp1–4*.
51. S. Khyati, "With CIMAP Help, Flowers at Ajmer Dargah to Bring Jobs", The Indian Express, https://indianexpress.com/article/cities/lucknow. 2010, May 10

CITATION OF THIS ARTICLE

Aruna Saini and Shelja.K.Juneja. Sustainable Management of Floral Refuse from Temples: A Review. Bull. Env. Pharmacol. Life Sci., Spl Issue [2]: 2023: 555-562.